Studies in the Life History and Ecology of the American Pintail (Anas Acuta Tzitzihoa Vieliot) in Utah

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STUDIES IN THE LIFE HISTORY AND ECOLOGY OF THE AMERICAN PINTAIL

(*ANAS ACUTA TZITZIHOA* VIEILLOT) IN UTAH

by

Robert W. Fuller

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Wildlife Management

UTAH STATE AGRICULTURAL COLLEGE
Logan, Utah

1953

ACKNOWLEDGMENTS

It is with mixed feelings of pleasure and inadequacy that I express my appreciation for the varied assistance received during this study.

I am profoundly grateful to the four cooperating agencies of the Utah Wildlife Research Unit whose financial assistance made the study possible for me. Equally important and appreciated was the use of lands and equipment belonging to the Utah Fish and Game Department and the Wildlife Department of Utah State Agricultural College.

For project guidance, friendship, and a contagious sort of enthusiasm which conditioned this work, I am deeply indebted to Dr. Jessop B. Low, Leader of the Utah Cooperative Wildlife Research Unit. The technical advice and assistance of Mr. Noland Nelson, Utah Waterfowl Project Leader, were extremely valuable to the project; the close companionship of Mr. Nelson and his family will always be remembered. My thanks are extended to Tom Klett, Utah Assistant Waterfowl Project Leader, for manual assistance, helpful criticism, and a similar companionship.

Allen Smith and Hortin Jensen, Flyway Biologists, gave valuable counsel on a number of occasions; Mr. Dan Davis, Caretaker of the Bear River Gun Club, kindly permitted the use of that club and an airboat for one phase of the study; Dr. Carrol Draper, Head of the Poultry Department at Utah State Agricultural College, granted the use of an incubator and supplied helpful information on the incubation of duck eggs; data from Bear River Refuge on hunting and population levels were furnished by Mr. Vanez Wilson, Manager of that refuge; Wayne Heuer, former wildlife graduate student at Utah State Agricultural College, gave invaluable assistance in fluoroscoping a number of birds for lead shot and permitted the use of his data on lead poisoning in this work; Mr. Calvin Wilson, Curator of the Tracey Aviary in Salt Lake City, not only permitted but encouraged the use of the aviary's facilities, and supplied helpful information on some ornithological aspects of the study; to all of these people my most sincere thanks are offered.

I am further grateful to all of the members of my advisory committee at Utah State Agricultural College for spontaneously proffered assistance during the study and helpful criticism of my writing in the preparation of a manuscript for this thesis; those members are Dr. Jessop B. Low, Dr. William F. Sigler, Dr. George H. Kelker, Dr. Merthyr L. Miner, Dr. Clyde Biddulph, Associate Professor Arthur H. Holmgren, and Assistant Professor Merrill H. Gunnell.

To my wife, Beverly, for her never-ending assistance, inspiration, and faith in my efforts, this work is dedicated.

R. W. Fuller

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INTRODUCTION

> Wildlife management has been defined as "the manipulation of wild populations of vertebrate animals in their relation to man and his interests" . . . . Wildlife management, then, could not exist in the absence of either wildlife or humans. Converting this idea to the waterfowl situation, we can say that there are no waterfowl problems other than as they exist in the minds of men. (Mills, 1951)

These words by the Chief of the Illinois Natural History Survey precede a plea for fundamental facts and a basic understanding of waterfowl upon which sound management can in turn be based. For only through sound management can the waterfowl problems created by and existing in the minds of men be solved. Furthermore, an analysis of the whole requires an understanding of its components. These ideas focus attention on the individual species of waterfowl and further narrow attention to specific problems and specific areas.

Considerations of this type constituted the origin of this study of the pintail, one of the most abundant and widespread of North American waterfowl. Financed and directed by the Utah Cooperative Wildlife Research Unit as Project 123, field work for the study began in March of 1951 and terminated in December of 1952.

Purpose

The objective of this study was by no means a complete life history study of the pintail. In general, its purpose was an evaluation of the role which Utah plays in the life history of this species. Major emphasis was placed on migrations and populations, production and losses, with other phases receiving attention as time permitted. The data and conclusions from this study were intended to supplement similar studies in other areas, which have been or will be made, to give a well-rounded understanding of the pintail over the continent.

Scope

Actual field work was limited to the northwest one-fourth of the state, more specifically to Cache Valley and Salt Lake Valley south to, and including, Utah Lake. Such a limitation was imposed by several factors: (1) this area contained the largest marshes and major developments for waterfowl, (2) it was recognized as the approximate limits of the breeding range of the pintail in Utah, (3) being near the hub of Utah's most densely populated region it was the area of major hunting pressure, (4) botulism losses were largely confined to this area, and (5) time was limiting. The findings of this study and those of previous workers in the same and other areas were expected to apply to the state as a whole. Many of the data gathered were not simultaneously qualitative and quantitative, however; in such cases a strict interpretation of the data or their extension to other areas was impossible. An effort was made in the writing to emphasize this fact to the reader.

Methods of procedure

A general discussion of the techniques employed in the various phases of this study precedes the presentation and analysis of data in each major division of the writing which follows. Some of the methods are illustrated by photographs. Data are tabulated or graphically illustrated for the purpose of greater clarity.

Figure 1. The American Pintail (Anas acuta tzitzihoa). Adult male in nuptial plumage. (Photo by William J. McConnell)

REVIEW OF LITERATURE

Specific research on the American Pintail was very limited in the literature. Two life history accounts stood out above all others - those were the work of Kortright (1943) and Bent (1951). The majority of data in these two works represented a compilation from a wide number of sources. Among other contributors, Munro's (1944) studies in British Columbia represented original research on the pintail, that of Cottam (1947) was largely a summary of the findings of previous workers in Utah and North America, and Low (1949) made a valuable contribution to an understanding of pintail migration in an analysis of band returns from 175,000 banded pintails.

A vast amount of literature on specific problems or individual concepts in the life history of waterfowl in general includes data on the pintail, undoubtedly the result of the wide distribution and abundance of this species. Mention of only a few of the most important works of value to this study is permitted here.

Delacour and Mayr (1945) considered the taxonomic position of the pintail in their review of the Anatidae; Behle (1944) discussed the distribution of pintails in Utah. Lincoln (1939), Cartwright and Law (1952), and Van Den Akker and Wilson (1949) were additional sources of valuable information on migration. Research connected with sex ratios among pintails was particularly scanty although Hawkins (1940), Hochbaum (1939) and Petrides (1944) furnished data which could be compared with that from this study. With respect to nesting, the work of

Sowls (1949 and 1950) at Delta, Manitoba, on both nesting and renesting was distinctly beneficial, as was that of Williams and Marshall (1937 and 1938) at Bear River Refuge; Odin's (1951) study of predation by California Gulls was of value since 41 pintail nests were included in those which he observed. The number of pintails included in the study on ingested lead by Heuer (1952) was greater than that of any other species which made his results of particular importance to this study. With respect to food habits, Martin, Zim, and Nelson (1951) analyzed gizzard contents from 278 pintails collected in the west, and Martin and Uhler (1939) conducted similar research on 170 gizzards from approximately the same region.

Avian classification in this work follows that of the A.O.U. Check-list of North American Birds, 4th Edition, and the 19th to 25th Supplements to this check-list. Peters' (1931) check-list was consulted for other races of pintails. Plant and animal classification follow that of Holmgren (1948) and Anthony (1928), respectively. Schmidt and Davis (1941) were consulted for the name of the gopher snake.

DESCRIPTION OF THE STUDY AREA

General

With the exception of some limited work in Cache Valley and at Utah Lake, all investigations of this study were conducted along the eastern side of the Great Salt Lake. This is the largest waterfowl area in the state both from a nesting and hunter-use standpoint (Figure 4). Vast marshes have developed here on the deltas of 3 river systems - from north to south, the Bear River, the Ogden-Weber River, and the Jordan River. In addition, there exist many slough and pothole marshes in the irrigated, bottomland farm belt and along old river beds. There is probably no other area in the United States that has the concentration of nesting waterfowl found in this area (Nelson, 1949).

In extreme northern Utah (Cache Valley) is an area of marshland created by backwater from Cutler Dam and numerous small, meandering streams. A fair population of ducks and a few geese nest in this area, and good hunting is provided in the early season. Waterfowl production has been studied here recently by Wolf (1951).

There are about 30 private hunting clubs located around the east shore of the Great Salt Lake. These clubs own or control 42,143 acres of the better marshland along the lake shore (Nelson, 1949). Large numbers of ducks and geese feed and nest on these private areas.

Of the many other areas important to waterfowl (Figure 4), Utah Lake is probably the best from a production standpoint. This is a fresh water lake surrounded by farmland and marsh area readily accepted by a number of pintails.

Specific areas utilized for the investigations of this study include (1) Cache Valley, (2) Public Shooting Grounds, (3) Bear River Bird Refuge, (4) Bear River Gun Club, (5) Ogden Bay Refuge, (6) Farmington Bay Refuge, and (7) Utah Lake. The first and last of these are unmanaged areas, Bear River Refuge is federally administered, Bear River Club is privately owned and managed, and the remaining 3 are managed by the State of Utah.

Ogden Bay Bird Refuge

Approximately 90 percent of all field work for this project was conducted at Ogden Bay Refuge, Hooper, Utah. This refuge was established in 1938 by the state of Utah with the following management objectives: (1) to create and maintain more favorable nesting, feeding, and resting area for migratory birds, (2) to reduce the incidence of botulism in the avian population, and (3) to provide a suitable wildfowl hunting area.

Location and size. Located on the deltas of the Ogden-Weber River, 12 miles west of the city of Ogden, the refuge includes approximately 9,000 acres of developed marshland and a total area of 12,000 acres. This area is divided into 3 administrative units (Figure 2); 2 of these are enclosed by a series of earthen dikes while the third extends to the Great Salt Lake.

Elevation and topography. Although less than 15 miles from the rugged Wasatch Range, the refuge is exceeding flat and unbroken, having an average gradient from east to west of only 3 feet per mile. Elevation on the east side is 4,216 feet above mean sea level - 4,197 feet on the west.

Climate. Annual mean temperature for this area is about 64 degrees Fahrenheit; extremes range from -25 degrees in January to 106 degrees in

July. Rainfall averages 14.05 inches per year with extremes of 0.51 inches and 1.72 inches in July and February, respectively. Adding an average of 1.87 inches (condensation) to the total rainfall and subtracting an average of 13.46 inches (evaporation and transpiration) leaves a net amount of approximately 2.45 inches for runoff and ground storage. The growing season averages 160 days (U. S. Dept. Agric., 1941).

Water. Two rivers, the Ogden and Weber, unite just west of the city of Ogden and jointly supply the refuge with water. The spring runoff from these 2 is extremely heavy; however, diversion for irrigation purposes takes increasing amounts of the water after May, until the supply to the refuge is at a low of approximately 15 to 20 second-feet by mid-July. This low supply normally continues until sometime in September.

Dikes and water control structures on the refuge effect a very efficient use of the water at all seasons. Heavy runoffs are allowed to by-pass the refuge. Borrow pits collect their supply of water on the high side of each unit; draining to the west, the water is again collected in borrow pits and then spread over the succeeding unit.

Soils. Soils consist of clays and sandy clays overlaying a hardpan layer which varies in depth from 3 feet to well over 20 feet. Organic matter has increased rapidly in the last 10 years, reaching depths of 30 inches on some sites. Silt deposition has added 7 inches to preexisting soils of Unit II and lesser amounts elsewhere on the refuge. Salinities range from 0.2 percent to 3.5 percent at depths from surface to 24 inches (Nelson, 1949a).

Vegetation. Before its development, much of the present refuge area was a saline wasteland, barren and unproductive. Deep channels, cutting through the delta, drained the available water into the Great Salt Lake at a rapid rate. Greasewood (Sarcobatus vermiculatus) and an occasional small, isolated patch of alkali bulrush (Scirpus paludosus) were the principal species of plants (Anon., 1949).

Appendix Table 1, although incomplete, attests to the rapid transition of plant types since the area has been managed. Leaching of the soil and deposition of silt, induced by the control and utilization of water over the area, have brought about the changes.

Nelson (1940) found the ecesis of different plant species to be dependent upon a certain range of soil salinities, and that the least tolerant species were located in areas where leaching and silt deposition were greatest. A zonation in the vegetation around isolated areas of alkali flat on the present refuge was indicative of his findings. Moving outward from the center of such flats, one encountered glasswort (Salicornia), saltgrass (Distichlis), bulrush (Scirpus), and cattail (Typha).

Although some extensive areas of monotypes are to be found at Ogden Bay Refuge, one is impressed with the variety and interspersion of plant life existing on this refuge today. The ratio of vegetated to unvegetated area is currently estimated at 3:5.

Wildlife present. The wildlife at Ogden Bay Refuge is as diversified as the vegetation. The interested reader will find a partial list in Appendix Table 2. The list includes only those species identified by the writer during his study on the area.

The avifauna is by far the most conspicuous and numerous wildlife represented. The transformation from low winter numbers to the teeming,

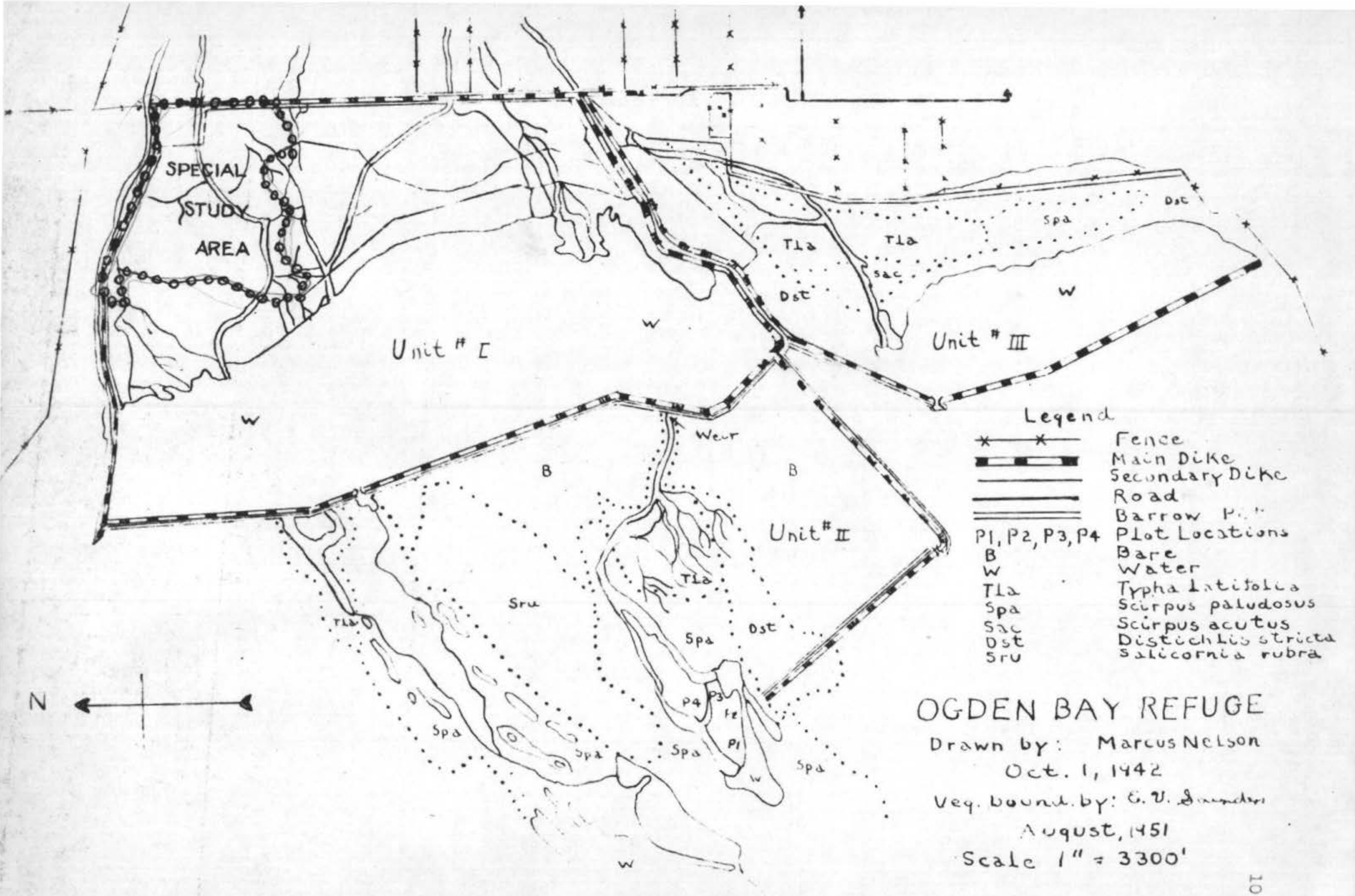

Figure 2. Ogden Bay Bird Refuge and the special study area for the pintail

surging, "here-today-gone-tomorrow" thousands of the spring migration is known to many people, understood by some, but appreciated by few. Even more spectacular in numbers are the thousands of birds which rest on the refuge during the southward migration in late summer and fall.

CHARACTERISTICS OF THE AMERICAN PINTAIL

Taxonomy

Current literature on the pintail classifies it in 1 of 2 genera, *Anas* or *Dafila*. The former classification was proposed by Linnaeus who grouped the pintails with the mallards and blackducks. At a later date, Stephens, believing the pintail deserved a separate generic rank, renamed these birds *Dafila*. The latter classification was recognized until the Committee on Nomenclature of the American Ornithologists' Union, in its nineteenth supplement to the Check-list of North American Birds, classified the pintail as follows:

- Class Aves
  - Subclass Neornithes
    - Superorder Neognathae
      - Order Anseriformes
        - Suborder Anseres
          - Family Anatidae
            - Subfamily Anatinae
              - Genus *Anas*
                - Species *acuta* *tzitzihoa* Vieillot

Anas has, therefore, become a composite group, containing all the species formerly listed in the genera *Chaulelasmus*, *Dafila*, *Eunetta*, *Nettion*, and *Querquedula*.

One other North American pintail is recognized by the American Ornithologists' Union (1931) - the Bahama Pintail (Anas b. Bahamensis Linnaeus), an essentially non-migratory species of the Bahama Islands and northern South America. This is 1 of 6 species of "tropical pintails" according to Delacour and Mayr (1945) as contrasted to their "true pintails". The Old World race (*A*. *a*. *acuta* Linnaeus) rarely visits Alaska and Greenland (Peters, 1931).

On this continent, the ranges of the North American and Old World races overlap very slightly in Alaska and Greenland, and there is a similar slight overlap of the American and Bahama races in the vicinity of the Florida Keys. A. a. tzitzihoa alone is known in Utah and all subsequent treatment will refer specifically to this pintail.

Common names in general usage include pintail, grey duck, pinnie, sprig, and sprigtail; the list of colloquialisms is longer: canard gris (grey duck), paille-en-queue (straw-tail), fall duck, grey widgeon, kite-tailed widgeon, long neck, necktwister, penttail, pheasant or pheasant duck, pickettail, pied grey duck, piketail, pintail widgeon, smee, smethe, smoke, spike or spiketail, spindle tail, splittail, springtail and springtailed widgeon, sprit-tail, and trilby duck (Kortright, 1943).

Description

The descriptions of the American Pintail given by Kortright (1943) for adults and immature birds, and those by Bent (1951) for downy young were found quite accurate during this study. It seems necessary here only to add other personal observations to the work of the above authors.

Females developed conspicuous black spots on their bills at the age of 5 weeks. Spotting was noted on all females handled in banding 888 pintails, and on all females inspected during botulism outbreaks and the hunting seasons of 1951 and 1952. The number and size of the spots increased with age until merging occurred and the spots became blotches of irregular dimensions. How long this increase in spotting continued was not learned during the study, but all adults showed this character to a greater degree than did immature birds. No males showing a similar bill marking were noted.

The appearance of the speculum separated the sexes at 5 to 6 weeks of age. Males, without exception, showed a conspicuous iridescent speculum of bronze, violet, and green from the time that they acquired their first remiges. Immature females possessed a dull brown speculum. The speculum of the adult female was but little brighter than that of the juvenile; although showing traces of color as in the male, it still lacked the iridescence displayed by her mate.

Bent (1951, p. 150) refers to something that this writer has never seen -- females showing pure white breasts in winter. The absence of this pattern in observations of paired spring migrants, local breeding pairs, and nesting hens suggests that it is of rare occurrence and unlikely to be of significance in sex ratio counts.

Hybridism

Perhaps the surprising thing about crosses in the wild is not that they occur but that their occurrence is not more frequent. Kortright (1943, p. 43) states that the wild mallard on this continent "crosses readily and repeatedly . . . with the pintail . . ." although the resulting hybrids are rarely fertile. Geneticists take a slightly different approach:

> Attempts have often been made to define species as forms which produce no hybrids at all or produce completely sterile hybrids. All such attempts break down. There exist species which are completely isolated reproductively, so that no hybrids occur in nature, and yet they can be crossed and produce fertile hybrids in experiments (for example, the Mallard and Pintail ducks, Anas platyrhynchos and Dafila acuta).
>
> --Sinnott, Dunn, and Dobzhansky, 1950, p. 356

In handling approximately 2,000 pintails and observing many more thousands of these and other species, only 2 hybrids involving a pintail parent were seen by the writer. Three others were recorded by other workers in the area. All were pintail x mallard crosses showing considerable variation. Common to all was the more tapered body, long neck, long tail feathers, and dark bill of the pintail. Two adults entering the breeding plumage showed an incomplete white neckring which turned upward on both sides of the hind-neck, and green coloring in the head feathers.

Mr. Calvin Wilson, Curator of the Tracey Aviary at Salt Lake City, reported that he had never witnessed crossing, or the hybrids from crosses, between pintails and other species held captive at that aviary.[1] A third generation mallard x pintail hybrid acquired elsewhere by Mr. Wilson and observed at this aviary was predominantly mallard in color pattern, but possessed a pintail bill, a white collar which turned upward on both sides of the hind-neck, and elongate tail feathers.

In addition to (1) the characters of the parents showing distinctly in the hybrid, and (2) a high percentage of sterility in the mongrels, Kortright (1943, p.44) notes a greater scarcity of females and an excess of males among hybrids.

Hybridism may, therefore, be summarized as follows:

1. Crossing in the wild state occurs with a rather high sterility in the resulting progeny.

2. The perpetuation of hybrids is limited by this sterility and an unbalanced sex ratio.

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1. Personal interview

DISTRIBUTION

Continental

Three factors contribute to the probability that the pintail is one of the best known of North American waterfowl: (1) the distinctive, gracefully handsome appearance of the drake, (2) the abundance of the species throughout its range, and (3) a breeding range which is wider than that of any other duck except the mallard (*Anas p. platyrhynchos*).

Breeding range. Abundance of the species is largely attributable to its vast, undisturbed breeding grounds in northern North America (Figure 3). The most densely populated breeding grounds are in Alaska (Munro, 1944) but the range extends from the Arctic coast of northwestern North America east to Hudson Bay and James Bay, south to northern Illinois, central Iowa and west to central California, Oregon, western Washington, central British Columbia and the Bering Sea coast of Alaska.

Bent (1951) cites records of pintails breeding in New Brunswick, Ontario, and southeastern Michigan; Braund and McCullagh (1940) have found pintails nesting on Anticosti Island, Quebec.

Winter range. Wintering populations of greatest size are noted along the Pacific Coast from southern British Columbia to Central America, in the interior valleys of California, along the Mississippi Valley to the Gulf Coast and down the Atlantic Coast from Chesapeake Bay to the Bahamas, West Indies, and Panama. Cottam (1947) thought the coastal states, from Washington and New Jersey southward, received the heaviest concentrations while Munro (1944) called western Oregon and the wide interior valleys of California the chief wintering grounds. From an

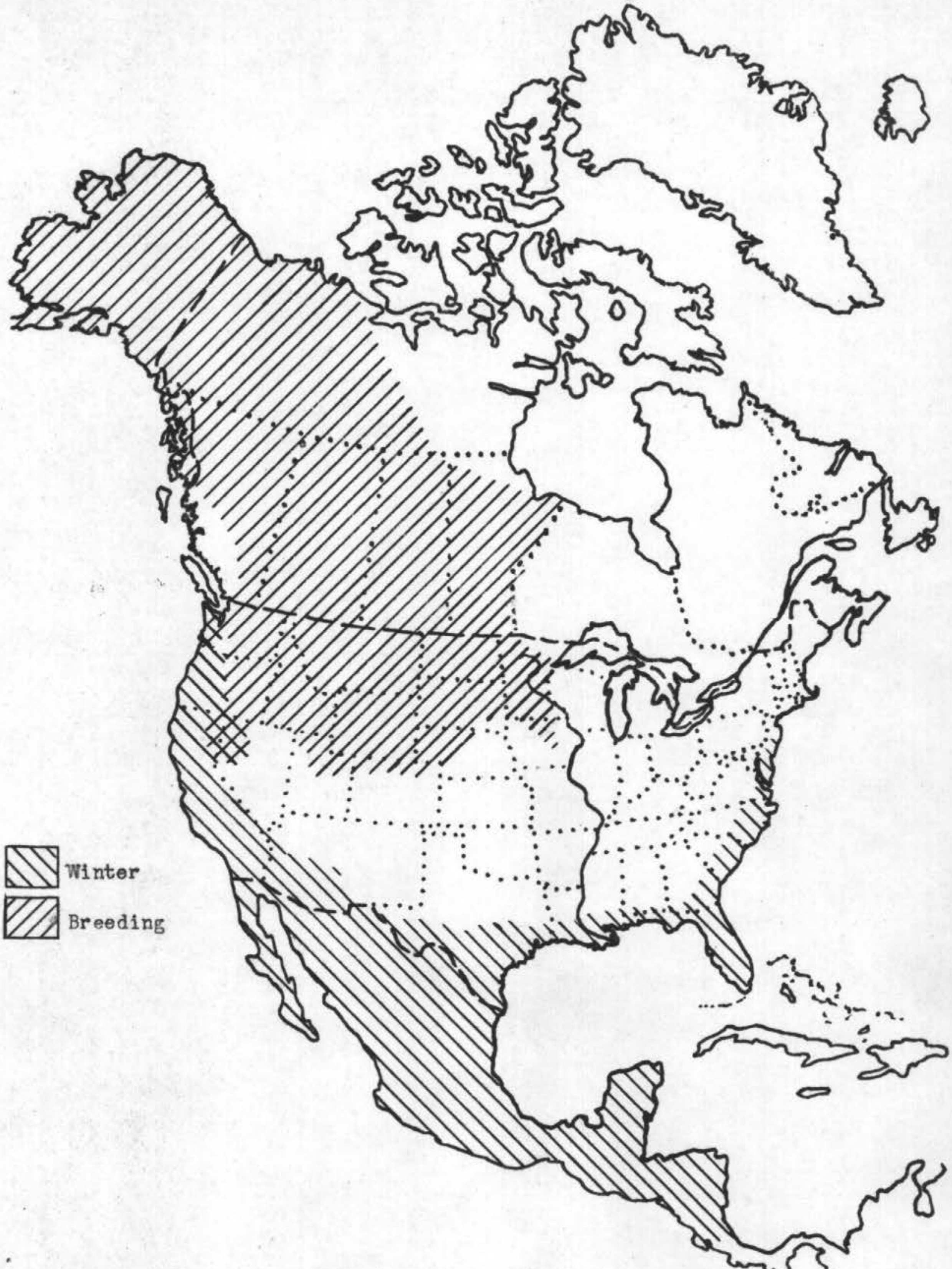


Figure 3. Main ranges of the American Pintail (From Kortright, 1943)

analysis of banding data, Low (1949) concluded that the Puget Sound region of the Pacific Northwest was a major wintering ground as well as areas in California, Texas, Louisiana, Mexico, and Central America. On the Pacific Flyway wintering grounds, pintails were the most abundant single species during the winters of 1949-50 and 1950-51 (Crissey, 1951). A few birds spend the winter in the Hawaiian Islands. An unusual record of this is that of a male pintail banded at Bear River Refuge, Utah, on August 15, 1942, and found exhausted at Palmyra Island, T. H., on November 5, 1942. The bird had travelled at least 3,500 miles in 83 days (Van Den Akker and Wilson, 1949).

Casual reports. East of the Mississippi River, pintails have been banded and/or retaken in small numbers in nearly every state and province (Low, 1949). Greenland, Labrador, Southern Baffin Island, Laysan Island, and southern England are other places for which visits of the American Pintail have been recorded. Low also reported an immature male banded at Tinker Harbor, Labrador, on August 19, 1948, and shot on the river Dart, Southern England, on September 15, 1948.

Utah

Pintails may nest in Utah wherever waterfowl habitat and nesting cover to their liking is to be found. Nesting pintails have been located throughout Salt Lake Valley, at Clear Lake, Fish Lake, Utah Lake, Stewart's Lake, Strawberry Reservoir, along the Green River and many other streams, lakes, reservoirs and sloughs. Behle (1943) classifies the pintail as a transient in southwestern Utah but belonging to a group which may nest occassionally along the Virgin River. However, the greatest breeding populations are to be found in or adjoining the marshes of the Great Salt Lake and the marshes of Cache County in

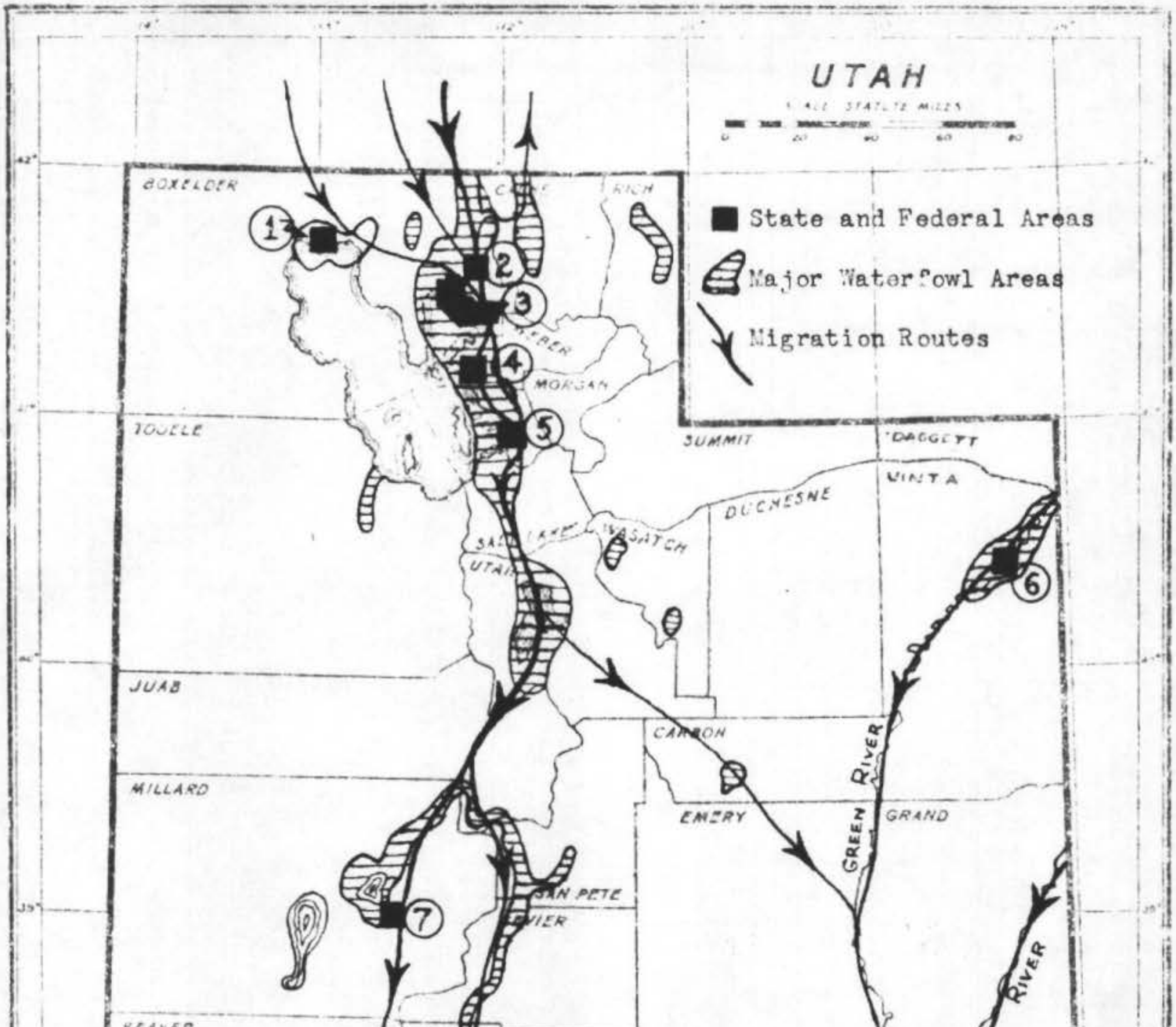


Figure 4. Major waterfowl areas and migration routes in Utah

extreme northern Utah.

Wintering populations appear to fluctuate according to weather conditions in Utah during the fall migration and winter. Given open water in proximity to a food supply, pintails are always to be found in the Salt Lake Valley during the winter. In the fall of 1952, however, cold weather closed practically all water areas during migration and pintails were very few in number in the Salt Lake Valley despite an unusually mild winter which followed.

Behle (1944) lists the pintail as a summer resident in Northern Utah, a common migrant throughout the state, but wintering in small numbers only occasionally.

The number of pintails which migrate through Utah exceeds beyond imagination the number which nest or winter in the state. The main route of movement is lengthwise through the center of the state (Figure 4). A smaller flight appears to follow the Colorado and Green Rivers across the southwest corner of the state. It is possible that some northbound migrants travelling up the Green River turn northwestward along the Price River in Emery County, passing through Price Canyon to join the flight moving through central Utah (Hardy, 1947).

MIGRATION AND POPULATION PATTERNS

For the greater part of each year the pintail is Utah's most abundant duck, although the numbers of this species encountered in late summer and through the fall are more spectacular than at other times of the year. Chronological and phenological aspects of movements in and through Utah, along with the resultant population levels, have been recorded on key areas for a number of years. In terms of this type of data, however, little has been learned of the vicissitudes of sex and age composition.

Munro (1944) felt that a sexual unbalance of important magnitude existed in this species with females predominating. Could such a condition exist in Utah? Records from previous years suggested that the opposite condition of sexual unbalance might be realized in this state during the fall. Could a differential sex migration be entirely responsible for the latter effect? Of what importance were migration patterns to botulism and hunting season losses from the standpoint of numbers and of sex and age? A sizeable June-July influx of pintails to Utah marshes had been noted for years (Cottam, 1947). What was the sex and age composition of this influx and what areas did the birds utilize? These were specific problems which the study of migrations and populations proposed to investigate.

Methods of procedure

Patterns of migration and population levels were determined by regular bi-monthly censuses on state areas. These combined actual counts and on-the-spot estimates made by driving and walking along dikes and water courses. When deemed advisable, a shotgun was fired to flush hidden birds from the more inaccessible areas as a further check on the estimate. Field notes supplemented these data between census dates.

From December to the last of May sex ratios were determined by visual counts of the birds on the basis of dimorphic plumage. Trapping, botulism losses, and hunters' bag checks supplied this type of data for late summer, fall, and early winter periods. Under federal permit, 20 birds were also collected from the June-July influx.

Trapping included the use of 3 types of traps. All but 30 of the trapped birds were taken in a semi-permanent type trap which employed chicken wire sides and a top of fish netting; the funnel to this trap and the area immediately in front of it were baited with corn or wheat to lure the birds.

In the summer of 1952, 350-foot wings of chicken wire were set up on a lake at the Bear River Gun Club; to the apex of these wings a chicken wire enclosure of approximately 2,500 square feet was attached; this, in turn, narrowed toward the rear to lead into a semi-permanent trap. An attempt was then made to drive flightless pintails into the wings, the enclosure, and on into the trap. Although this instance of "driving" failed, the method is applicable to flightless pintails in water up to 3 feet in depth provided enough personnel are available for the drive.

The third method of trapping employed the use of a cannon-projected net trap (Figure 44) of the type described by Dill and Thornsberry (1950). Use of this device was limited to dikes along the lee borders of which pintails frequently massed to avoid high winds or to loaf.

Most of the birds proved too wary, however, and usually moved elsewhere when the net was set up in a given location.

Coincident with 1952 trapping and banding, 55 pintails (20 adult and 35 immature) were wing-painted before being released. Testor's airplane dope (lemon yellow) was applied to the distal half of the upper side of one wing which distinguished the birds in flight at a distance of one-quarter mile. This procedure was intended to supply information on the length of time spent in the area by individual birds.

Spring migration

Chronology. Vying with the mallard for the distinction of being the first spring migrant, the hardy pintails push northward with the first breaking up of winter. Disregarding wintering populations, migrants are to be noted in Salt Lake Valley by late January or early February.

Bent (1951) referred to 2 distinct flights of this species in the spring and a similar pattern was to be noted in Utah. The peak of the first wave was noted during the last 2 weeks of February in 1952, while the second peak occurred around the middle of March. Low (1952) reported a peak of 48,500 pintails at Bear River Refuge on March 27, 1952. Two days later, the writer witnessed a concentration of pintails estimated to number 20,000 birds and showing a sex ratio of 103 males to 100 females; this group appeared to be resting and feeding on the salt-grass and alkali flats bordering the Bear River east of Bear River Refuge, but had moved on by April 4. In the same year, a peak of 55,000 pintails was recorded at Ogden Bay Refuge on March 15 (Table 5). It should be emphasized that bi-monthly censuses may fail to reveal the true peak of spring migration for the pintail; so rapid is its course that numbers may double and halve again, all in a period of 2 weeks.

Table 1. Sex ratios of pintails at Ogden Bay Refuge during the winter and spring - 1951 and 1952

	Males		Females		Sex Ratio (M:F)	
Period	1951	1952	1951	1952	1951	1952
Jan. 1 - 15	----	1152	----	301	----	382:100
Jan. 16 - 31	----	23	----	4	----	575:100
Feb. 1 - 14	----	934	----	521	----	179:100
Feb. 15 - 28	----	475	----	419	----	113:100
Mar. 1 - 15	----	1571	----	1429	----	110:100
Mar. 16 - 31	434	1000	416	970	104:100	103:100
Apr. 1 - 15	132	752	104	742	127:100	101:100
Apr. 16 - 30	47	25	43	9	109:100	278:100
May 1 - 15	55	36	25	14	220:100	258:100
May 16 - 31	22	18	8	6	275:100	300:100
Season	690	5986	596	4415	116:100	136:100

Table 2. Estimate of total breeding pairs of waterfowl on state refuges from dike-line census[1]

	Ogden Bay		Farmington Bay		Public S. Grounds	
Species	1951	1952	1951	1952	1951	1952
Canada Goose	142	118	68	75	34	32
Mallard	260	325	137	125	115	200
Gadwall	244	317	88	150	64	35
Pintail	154	225	76	55	71	55
Cinnamon Teal	365	625	180	225	172	175
Redhead	388	510	173	220	261	230
Shoveller	180	63	69	63	34	25
G.-W. Teal	2	2	0	0	0	0
B.-W. Teal	12	22	5	4	7	3
Ruddy	32	18	17	16	3	3
Baldpate	0	2	0	0	0	0
Total	1779	2227	813	933	761	758

1. Data from Nelson (1952)

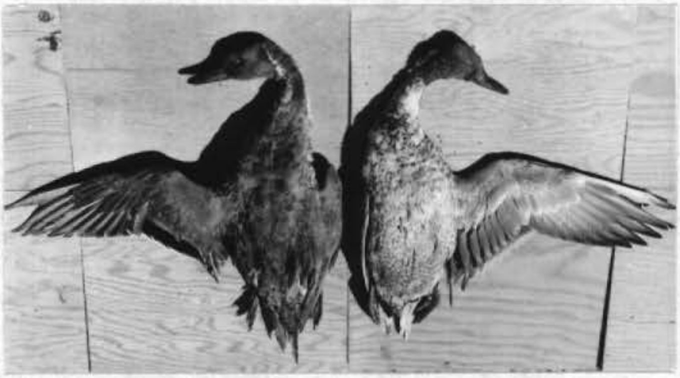


Figure 5. Adult male pintails collected at Ogden Bay Refuge, June 21, 1952. Except for flight feathers, post-nuptial molt was nearly complete.

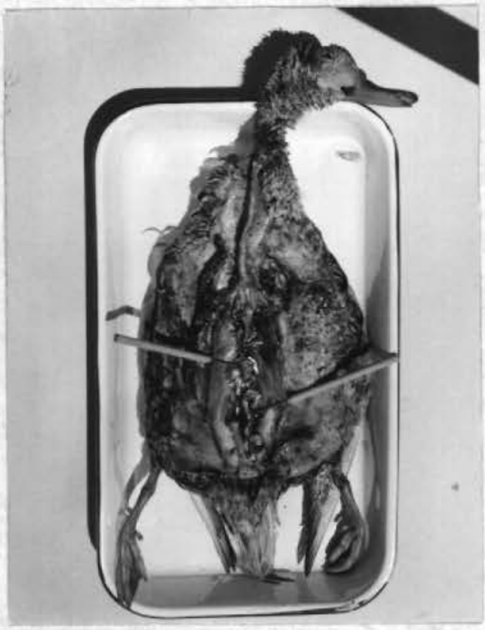


Figure 6. Adult female pintail collected at Ogden Bay Refuge, June 14, 1952. Ovary (upper needle) showed no indication of ovulation having occurred. Lower needle indicates oviduct.

Figure 7. Adult male pintail collected at Ogden Bay Refuge, June 14, 1952. Testes still greatly enlarged. Upper needle indicates sperm duct; lower needle pierces the penis.

Climatic differences between Salt Lake Valley and Cache Valley have frequently delayed the noticeable arrival of birds in the latter area by as much as 2 weeks. Bizeau (1951) recorded a peak migration of pintails at Gray's Lake, Idaho, in the period April 11 to 16, practically simultaneous with the first arrivals there.

Sex ratios. In addition to calendar differences of movement, 3 other features distinguished the second wave from the first during this study: (1) the second wave contained much larger numbers, (2) it showed a greater number of mated birds and less pre-nuptial courtship, and (3) it contained a better balance of the sexes. (Sex ratio counts during this period (Table 1) attested to the increase of paired birds as the season progressed. The sharp rise in the male fraction of the ratio noted in early May and late April of the 2 years reflected the beginning of nesting and the influence of lone males on the count.)

Resident population

Following the second peak of migration, the percentage of pintails in the population dropped sharply (Table 4 and Figure 9), reaching a maximum low in numbers by the first of May. Since the breeding population was considered stable at this time, estimates of the total number of pairs on 3 state areas were made during May. These data, obtained in the same manner as regular censuses, showed a sizeable increase in 1952 for Ogden Bay and moderate decreases in breeding pairs of pintails at Farmington Bay and Public Shooting Grounds (Table 2).

Mid-summer influx: numbers, composition, and areas utilized

(An annual influx of pintails to the northern Salt Lake marshes has been recognized for years.)(In 1916, Alexander Wetmore noted a sudden population increase by early June (Cottam, 1947).)

In 1951 and 1952, this influx also was noted early in June, numbers mounting throughout the month. By June 14 in the former year, a concentration of 7,500 birds was observed at Ogden Bay and a similar group of approximately 7,500 was again noted on June 28, 1952. A check on species composition showed 85 percent of this number to consist of pintails. These birds appeared to remain separate and distinct from the population within the refuge; they were extremely wild and wary, and spent the entire day on the shallowly-flooded flats just north of the refuge. The influx appeared limited to the northern Salt Lake marshes since comparable congregations were not noted at Farmington Bay. (See Table 5 for the month of June.)

Workers in the area have considered the influx to consist of post-breeding males congregating for the molt. An attempt was made to qualify this theory since a number of birds showed plumage characteristic of females. Trapping proved absolutely fruitless in 1951; accordingly, a federal permit authorizing the collection of 20 birds by gun was secured in 1952.

With the exception of 1 bird collected on June 14 and another on June 28, it was impossible to tell with certainty the sex of any of the birds collected while they were in flight; such birds were purposely selected to determine if they were females. The wildness of the birds made the collection of 3 birds in 1 day very difficult most of the time.

Results of this collection are shown in Table 3. Examination of one female collected on June 14 and a second taken on July 8 did little to clarify the situation. On 2 occasions in 1952, courtship flight of the type associated with renesting (see page 130) originated from this concentration. Conclusion 1 was possible - that the females collected

Table 3. Sex and age of pintails collected at Ogden Bay Refuge from the annual mid-summer influx - 1952[1]

Date	Age	Sex	Plumage
June 7	Adult	Male	Post-nuptial molt
June 7	Adult	Male	Post-nuptial molt
June 7	Adult	Male	Post-nuptial molt
June 14	Adult	Male	Post-nuptial molt
June 14	Adult	Female	
June 14	Adult	Male	Post-nuptial molt
June 21	Adult	Male	Post-nuptial molt
June 21	Adult	Male	Post-nuptial molt
June 21	Adult	Male	Eclipse
June 28	Adult	Male	Post-nuptial molt
June 28	Adult	Male	Post-nuptial molt
June 28	Adult	Male	Post-nuptial molt
July 8	Adult	Male	Eclipse
July 8	Adult	Male	Post-nuptial molt
July 8	Adult	Female	
July 15	Adult	Male	Post-nuptial molt
July 15	Immature	Male	Juvenal
July 15	Adult	Male	Eclipse
July 22	Immature	Male	Juvenal
July 22	Immature	Male	Juvenal

1. Federal Collecting Permit No. 9150, USDI, Fish and Wildlife Service

were local nesters intent on obtaining a renesting partner. On the other hand, if these females were a part of the influx and the collected sample was at random from a normally distributed population, it might also be concluded that 10 percent of the influx consisted of non-breeding or unsuccessful females. While the occasional presence of a non-breeding or unsuccessful female in the influx was not questioned by the writer, limited data and the law of parsimony dictated a preference for the former conclusion.

Since local broods may be flying as early as June 23, no conclusions regarding the point of origin of the immature birds collected are possible.

In addition to these 20 birds in post-nuptial molt or eclipse plumage, a completely flightless adult male was caught at Ogden Bay Refuge on June 28, 1952. From these data it was concluded that sexes may be indistinguishable on the basis of plumage alone early in June.

(Munro (1944) suggested that migration occurred during the eclipse and that flight feathers were molted at some more southerly area. Lincoln (1939, p. 68) wrote:

> . . . during the latter part of July, I have witnessed the arrival there [Bear River marshes of Utah] of large flocks of southward bound drakes, while a month later male pintails are common in the vicinity of Salton Sea in southern California.

In a letter to Petrides (Petrides, 1944), Lincoln stated that "large numbers of pintail drakes migrate much earlier than do the hens" and again cited observations of male pintails in eclipse plumage in the vicinity of the Salton Sea area.)

Probably due in part to the fact that the northwest flats at Ogden Bay became dry by the first of July, the concentration disappeared from

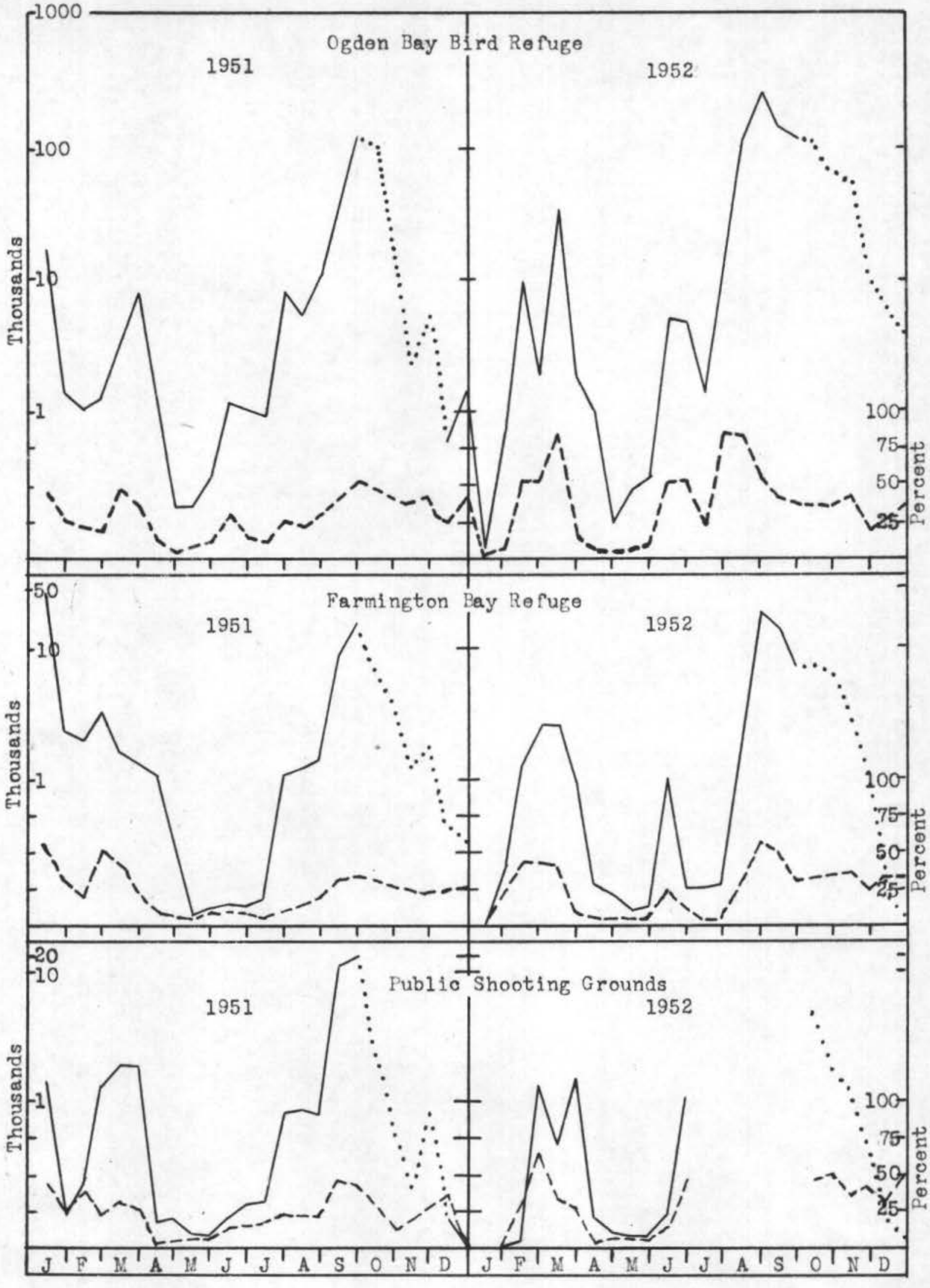


Figure 8. Bi-monthly pintail population from dike-line census. Broken line is percent of total population; dotted line is hunting season estimate.

Table 4. Bi-monthly census of waterfowl populations and pintail component of the total number

Date		Ogden Bay Refuge 1951	Ogden Bay Refuge 1952	Farmington Bay 1951	Farmington Bay 1952	Public S. Grounds 1951	Public S. Grounds 1952
1/15	Total No.	64135	7216	88110	6	5123	0
	% Pintail	45	(1)*	53	(0)	45	
1/30	Total No.	9015	14901	13000	1930	859	0
	% Pintail	26	(6)	31	(21)	(26)	
2/15	Total No.	5584	19406	16888	4092	1199	93
	% Pintail	22	50	(21)	43	(38)	32
2/28	Total No.	9758	6507	10980	10069	7923	3110
	% Pintail	(20)	51	50	43	(23)	64
3/15	Total No.	12155	66255	7496	11167	10611	2241
	% Pintail	47	83	39	39	(32)	(32)
3/30	Total No.	27391	22983	9280	11559	12582	9569
	% Pintail	(33)	(14)	23	(8)	(27)	(26)
4/15	Total No.	14591	23588	13339	6605	4966	5180
	% Pintail	(12)	(4)	(9)	(4)	(3)	(4)
4/30	Total No.	12487	8311	7540	4740	5465	1907
	% Pintail	(3)	(3)	(7)	(4)	(4)	(5)
5/15	Total No.	4414	8685	1375	2830	1485	1517
	% Pintail	(8)	(5)	(4)	(4)	(5)	(5)
5/30	Total No.	4608	7081	1444	2535	1474	1370
	% Pintail	(12)	(8)	(8)	(5)	(5)	(6)
6/15	Total No.	5591	13679	1532	4255	1418	1643
	% Pintail	28	52	(8)	23	(13)	(14)
6/30	Total No.	7834	13485	1598	2413	1836	2664
	% Pintail	(13)	51	(8)	(10)	(16)	45
7/15	Total No.	8914	10266	3289	7060	1785	----
	% Pintail	(11)	21	(5)	(3)	(18)	
7/30	Total No.	35537	17754	13856	7711	4177	----
	% Pintail	26	84	(9)	(3)	(22)	
8/15	Total No.	38039	164357	12553	11630	4246	----
	% Pintail	21	81	14	29	(22)	
8/30	Total No.	41930	867115	13599	56609	4071	----
	% Pintail	30	55	19	57	(22)	
9/15	Total No.	153435	536132	31709	42255	22705	----
	% Pintail	40	42	29	50	45	
9/30	Total No.	334887	422836	85438	28375	45440	----
	% Pintail	52	36	33	30	42	
10/15	Total No.	----	335163	----	28289	----	15802
	% Pintail		(36)		31		46
10/30	Total No.	----	236578	----	24282	----	6721
	% Pintail		35		34		48
11/15	Total No.	----	179723	----	14896	----	4976
	% Pintail		42		35		36
11/30	Total No.	----	51350	----	5000	----	1528
	% Pintail		(20)		(24)		41
12/15	Total No.	----	31056	----	1267	----	550
	% Pintail		(27)		(24)		(32)
12/30	Total No.	----	19133	----	311	----	253
	% Pintail		(32)		38		47

* Parentheses denote greater abundance of another species during that census

Table 5. Comparison of the bi-monthly censuses of pintail populations in Utah

	Ogden Bay Refuge[1]					Farmington Bay[1]				
Date	1949	1950	1951	1952	Ave.	1949	1950	1951	1952	Ave.
1/15	----	138	28500	50	9562	----	86	46509	0	----
1/30	----	115	2300	825	1080	----	94	4200	400	1564
2/15	----	9420	1200	9750	6790	----	4806	3500	1775	3360
2/28	700	8200	1914	3239	3526	3000	5700	5495	4600	4698
3/15	15510	12600	5700	55000	22202	22650	5400	2900	4350	8825
3/30	7100	11200	9037	3200	7634	12290	8900	2100	947	6059
4/15	559	530	1783	1001	9682	369	875	1210	250	676
4/30	498	495	350	221	391	199	110	520	200	257
5/15	543	460	357	456	454	140	105	60	100	101
5/30	632	500	563	557	563	167	110	118	125	130
6/15	15327	12500	1547	7142	9129	160	108	128	1000	349
6/30	18560	52200	7012	6930	19675	575	112	130	255	268
7/15	32400	50000	960	2145	21376	995	107	178	250	382
7/30	31440	22000	9166	14440	19261	840	5600	1300	275	2003
8/15	30525	25500	7500	133175	49175	1490	5200	1750	3400	2960
8/30	82450	44150	12400	476330	153832	21200	5964	2630	32420	15553
9/15	112860	76300	62150	227120	119607	35720	22000	9250	21200	22042
9/30	175500	160500	173000	150500	164895	39860	31400	27900	8500	26915
10/15	215000	165000	----	125410		35600	25300	----	8700	
10/30	196200	180000	----	83400		42000	28750	----	8310	
11/15	175000	125000	----	75300		40500	22000	----	5300	
11/30	165000	98700	----	10420		40200	15000	----	1210	
12/15	65700	71200	----	8475		12800	18400	----	195	
12/30	175	29760	----	6310		15	34500	----	22	

1. Data from Nelson (1949b, 1950, 1951, and 1952)

Table 5. (Continued)

	Public Shooting Grounds[2]				Bear River Refuge[3]	
Date	1949	1950	1951	1952	1951	1952
1/15	----	76	2300	0	7500	10
1/30	----	75	220	0	----	600
2/15	----	115	450	30	10000	150
2/28	----	650	1855	2000	15000	500
3/15	5675	1200	3400	700	35000	48500
3/30	4174	1100	3350	2500	15000	----
4/15	82	150	165	200	----	----
4/30	125	125	195	100	1750	350
5/15	42	50	79	75	1200	1000
5/30	87	50	75	80	2500	-----
6/15	950	75	185	225	4800	4000
6/30	1240	250	298	1213	18000	40000
7/15	2200	1250	315	----	43000	45000
7/30	1750	1325	914	----	60000	78500
8/15	1820	4800	930	----	175000	192000
8/30	25630	5100	900	----	470000	355000
9/15	15420	22000	10200	----	280000	297000
9/30	14610	19000	18925	----	250000	558000
10/15	12400	19350	----	7300	180000	210000
10/30	11200	19000	----	3225	81000	300000
11/15	10140	17400	----	1800	65900	70500
11/30	3160	6650	----	630	16500	5000
12/15	1490	7430	----	178	1800	100
12/30	----	2518	----	118	10	----

2. Data from Nelson (1949b, 1950, and 1952)
3. Data supplied by Mr. V. T. Wilson, Manager.

the area at this time. (Since pintails were entering the flightless period, it was concluded that the birds did not move far, but congregated on certain areas for the completion of the molt. Reports from Assistant Refuge Manager John Bauman, and Flyway Biologist Hortin Jensen, both of whom were stationed at Bear River Refuge, supported this idea; they indicated the presence of 10,000 "flappers" on individual units of that refuge by July 10. Bear River Gun Club, adjacent to Bear River Refuge, was also utilized by flightless pintails. On July 29, 1952, the writer caught and examined 20 birds at this club and found them all to be adult males. Three days later, August 1, practically all birds at Bear River Refuge and the gun club were again on the wing.)

Many hours of search at Ogden Bay Refuge failed to reveal more than the 1 flightless male pintail previously mentioned. The reason for this apparent selectivity of molting areas was undetermined; in view of similarities in the areas in vegetation and water depths, differences in size seemed to be a factor. It was suggested, therefore, that when a choice is permitted between 2 areas which offer comparable water and escape cover, the greater potential seclusion of the larger area made it preferable to the smaller.

A single flightless female was observed during this study on August 27, 1951. (It seemed likely that females molted their flight feathers on the brood-rearing grounds; failure to concentrate and an irregularity of the event made "flappers" of this sex less conspicuous.)

Fall migration

Chronology. Unlike the spring migration, the southward movement of pintails is greatly protracted. Census data (Tables 4 and 5) show a marked increase in populations on the study areas beginning in the latter half of July. Figure 9 also illustrates the increase of the percent of pintails in the total population. Pintails literally pour into the Salt Lake Valley from this time until late September when peak numbers are generally noted for this species. Beyond this point, migration out of the valley exceeds that into it, and the population declines quite steadily. Migrants continue to move through the state during the hunting season, a November flight of adults generally producing a fine shoot at Ogden Bay Refuge. If weather conditions are favorable after the close of the hunting season, such birds very likely winter in Utah.

Banding, among other things, was intended to test the hypothesis that some pintails stopped in the Salt Lake Valley for extended periods of time. Subsequent recaptures of banded birds or band returns would indicate the minimum length of time spent in the area. Painting the wing of 55 birds was intended to supplement the test; in the event that such birds were not retrapped or shot, the painted wings distinguished them if they remained in the area and were sighted. All painting was done in a 10-day period ending on September 1.

The last observation of a painted bird was on September 22, indicating a minimum of 21 days spent in the area. Only 3 others had been sighted before this, the last on September 5, which suggested that some birds did not remain in the area for any length of time. One pintail was shot 40 miles northwest of Gallup, New Mexico, 49 days after being painted by the writer.

Thirty recaptures in 1952 indicated an average of 5.5 days spent in the area; this was of little value, however, since trapping had to terminate before the beginning of hunting. There was the further

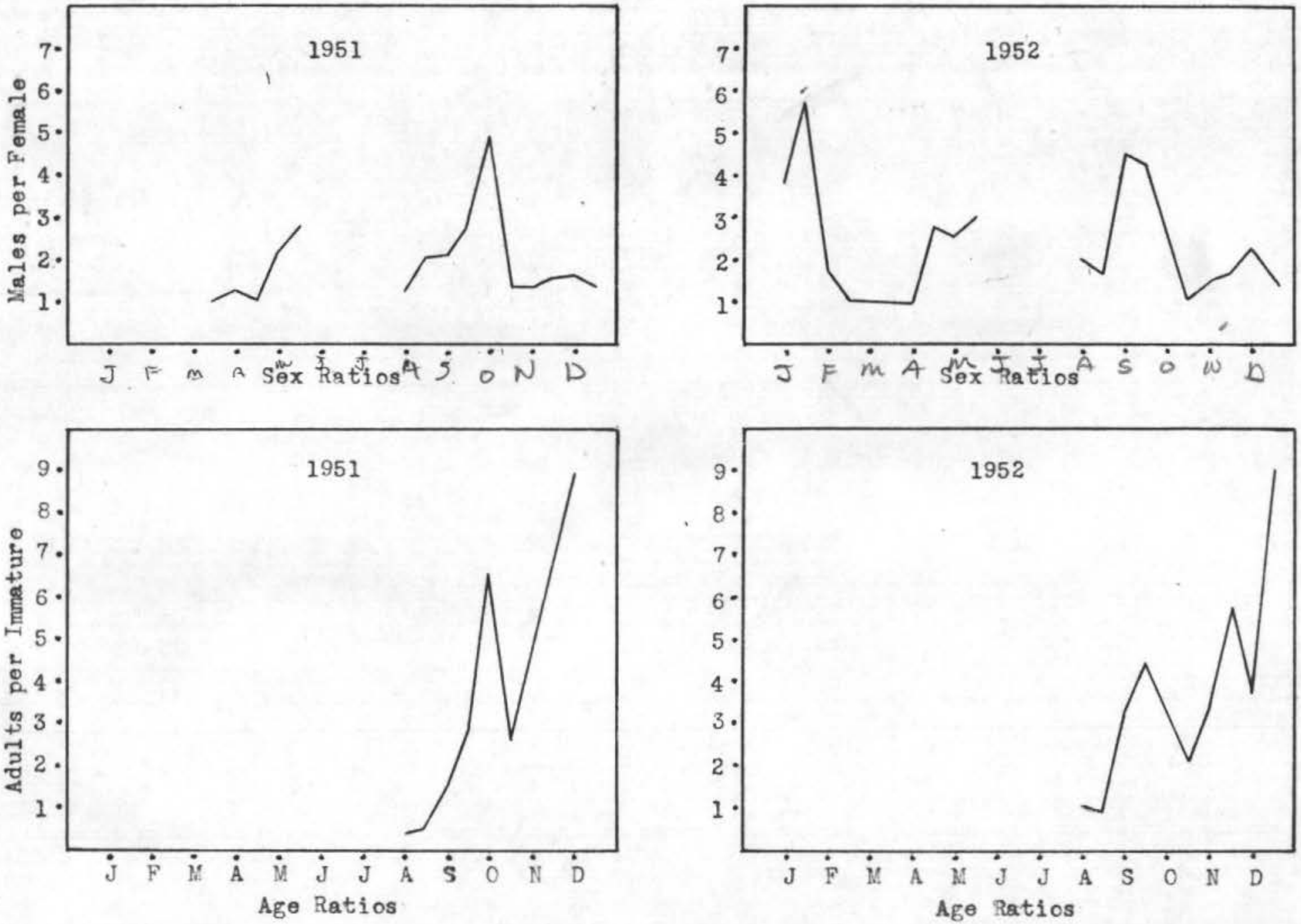


Figure 9. Comparison of sex and age ratios at Ogden Bay Refuge - 1951 and 1952. Combined data from observations, banding, botulism, and hunting.

possibility that baited traps were holding the birds longer than they might have been inclined to stay normally.

Band returns showed that some pintails spent from 25 to 93 days in the area (Table 6). There was, of course, no way of knowing how long the birds had been present previous to banding, nor how long they would have remained in the area had they not been killed. Nevertheless, these data were sufficient to satisfy the hypothesis of a delayed stop-over.

Sex ratios. Banding operations, botulism pickups, and hunters' bag checks over the 2 years of the study have provided sex and age data of importance to the discussion of fall migration. These data are summarized by 2-week and seasonal intervals in Tables 10 to 14 and in Figure 9.

In the case of the botulism data, the theory that sick birds might provide a better sample of sex and age trends than dead birds which had been laying around an unknown length of time was entertained. Division of the data accordingly (Tables 10a and 10b) revealed a fairly close agreement for the 2 groups, however. Furthermore, a rapid rate of decomposition during the botulism season meant that any dead birds which could be accurately sexed and aged when picked up could not have been dead too long. Therefore, the combined data (Table 10c) were considered more representative because of the larger sample size included.

Petrides (1944) suggested that banding traps were selective with respect to the sexes, males entering more readily than females. Hawkins (1942) found evidence of this for the mallard. Assuming that botulism, in the same period as banding, was not selective of sex, a comparison of sex ratios from the 2 sources was expected to reveal any selectivity by showing a markedly higher number of males from trapping than from banding. Table 13 shows the lack of a consistent relationship of this type in each year of the study and directly opposite relationships in season totals from one year to the next. Therefore, sex selectivity in trapping is not indicated, but a differential sex migration is suggested by these data.

A closer agreement between botulism and banding data was anticipated than was realized in Table 13. Comparatively smaller sample size may have skewed the banding data; a similar effect on the botulism data may have been imposed by variation in sex and age composition on a given area and variation in toxicity on that area. Accordingly, data from these 2 sources were compromised in Table 12 which represents a weighted average for each period.

All of the data on age ratios are fairly consistent in showing a maximum low in the adult fraction for the period August 16 to 31. Subsequent to this period the ratio becomes increasingly unbalanced by adults. From this it is inferred that the migration pattern is characterized by a differential age movement with (1) a migration of immature birds out of the area after this low ratio period, (2) a migration of adults into the area, or (3) a combination of both types of movement. In any event, disregarding the movement of adult males in congregating for the molt, it may be stated that immature birds precede adults in the southward migration.

A Chi-square test at the 95 percent level applied to the sex composition of the immature birds trapped, shot, or picked up with botulism revealed a significant unbalance from an expected 1 to 1 ratio with males predominating. Nevertheless, when compared with the adult population, the sexual variation among immature migrants was much less pronounced. Therefore, an increase in the number of immature birds in a given area during migration would tend to equalize the sex ratio more than would an increase in the number of adults; changes in sex ratio, therefore, would reflect a differential age migration. Since sex and age ratios from trapping and botulism losses showed chronologically similar trends, 1 type of ratio fortified the other in corroborating the hypothesis of differential movement.

Data from the hunting season (Table 14) show a rapid rise in the number of adults per immature birds present. Pintails may continue to move into the valley during this period but the outward migrants are greater in number as indicated by a decrease in population size after late September. It seems reasonable to assume that hunting is non-selective of age classes. It may be concluded, therefore, that the increase in age ratios reflected the departure of immature birds.

Sex ratios during the hunting season of 1951 and 1952 averaged approximately 150 males per 100 females as compared to 250 males per 100 females in the 2 months preceding hunting. The lower ratio existing during the hunting season was undoubtedly attributable to the arrival of adult females in October, November, and December; otherwise, the sex ratio for this period would be expected to show a greater proportion of males than it did during the botulism season.

Band returns

Low (1949) made a preliminary study of pintail migration from returns on banded birds. His report was based on some 30,000 returns from the banding of 175,000 pintails since the inception of the bird banding program. The study revealed that when indirect recoveries (adult birds only) were added to direct recoveries,[1] the percentage of returns from the Pacific Flyway rose consistently at the expense of the Mississippi and Central Flyways. This was considered evidence for a round-robin, counter-clockwise migration involving more than 1 flyway. A second possible conclusion was a differential age migration, with immature birds passing through California prior to the hunting season.

The analysis of 875 returns from Utah-banded pintails disclosed that 45 per cent of the recoveries came from within the state, 20 per cent from California, 10 per cent from Texas, 5 per cent from Mexico, 5 per cent from Canada and Alaska, and the remaining 15 per cent from a number of states, mostly west of the Mississippi River. A strong trend to the Gulf coast was noted by Low for Utah birds, but whether they moved to this region by way of California and Mexico or by a direct route was unknown.

Six hundred and thirty-nine returns from over 12,000 pintails banded at Bear River Refuge (Van Den Akker and Wilson, 1949) disclosed a wide dispersal of birds in the first year after banding. First year returns came from 16 states (2 east of the Mississippi), Canada, Mexico, Honduras, and the Territory of Hawaii. Returns were also received from all years from 1 to 12 inclusive, subsequent to banding, although 89 per cent were received in the first 4 years after banding.

Pintails from widely separated regions have been recovered, shot or found dead in Utah. Low (1949) indicated that some portion of the Alaskan birds which reached California migrated south by way of the

1. By direct recovery is meant a recovery of a bird in the same migration period in which the bird was banded. All others are considered indirect. Direct recoveries may, therefore, include both adult and immature birds, while indirect can only be adults. (Low, 1949)

Table 6. Direct within-state recoveries of Utah-banded pintails - 1951 and 1952

Locality	Age	Sex	Banded	Recovered	Elapsed No. Days
Ogden Bay Refuge	I	F	8-27-51	11-22-51	87
Ogden Bay Refuge	I	M	9- 3-51	12- 5-51	93
Ogden Bay Refuge	A	F	9- 4-51	11-17-51	74
Bear River Refuge	I	M	9-13-51	11- ?-51	48+
Ogden Bay Refuge	A	M	9-24-51	11-25-51	61
Ogden Bay Refuge	A	F	9-24-51	11-27-51	63
Ogden Bay Refuge	A	M	10- 3-51	12- 3-51	61
Bear River Refuge	-	M	8- 9-52	11- 2-52	85
Ogden Bay Refuge	I	M	8-22-52	10-18-52	57
Ogden Bay Refuge	A	F	8-24-52	10-19-52	56
Bear River Refuge	A	M	9- 5-52	11- 1-52	57
Ogden Bay Refuge	A	M	9-14-52	10-18-52	34
Ogden Bay Refuge	A	M	9-23-52	10-18-52	25

Table 7. Summary of band returns from pintails banded at Ogden Bay Refuge - 1949 to 1952

		Returns to February - 1953				
		Utah		Out-of-state		
Date	Number Banded	1st Yr.	2nd Yr.	1st Yr.	2nd Yr.	Total
1949	133	3(2.3)*	1(0.8)	1(0.8)	2(1.5)	7(5.4)
1950	20	2(10.0)	0	0	0	2(10.0)
1951	521	33(6.3)	3(0.6)	7(1.3)	3(0.6)	46(8.8)
1952	367	9(2.4)	0	5(1.4)	0	14(3.8)
Total	1041	47(4.5)	4(0.4)	13(1.2)	5(0.5)	69(6.6)

* Parentheses indicate percent of number banded

Table 8. Yearly distribution of returns from Utah-banded pintails - 1929 to 1953. (Modified from Van Den Akker and Wilson, 1949)

Place of Recovery	Number of years from banding to recovery												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
Arizona	4	1	2		1		2						10
Arkansas		1			1								2
California	63	37	18	8	10	2	6	1				2	147
Colorado	3	3		1	1				1				9
Idaho	3	3											6
Illinois	1												1
Iowa			1	1									2
Kansas	2	1	1	3									7
Louisiana	5	3	5	1									14
Minnesota	1	2	1				1						5
Missouri				1									1
Montana				1									1
Nebraska		2		2									4
New Mexico	4	2											6
North Dakota		1	2	1		1							5
Oklahoma	1	3				1							5
South Dakota	3	2	2										7
Tennessee	1												1
Texas	35	25	7	5	3	4	1	1	1				82
Utah	218	48	21	22	11	4	3	2			1		330
Washington	1	1											2
Alaska	1	3		1	2					1			8
Canada	3	15	9	4		7	1	2					41
Mexico	15	7	6	2	2	1	1	1	1				36
Honduras	1												1
Hawaii	1												1
Total	367	162	76	53	31	20	15	7	3	1	1	2	738
Cumulative Total	367	529	605	658	689	709	724	731	734	735	736	738	

Figure 10. Distribution of 738 returns from Utah-banded pintails - 1929 to 1953

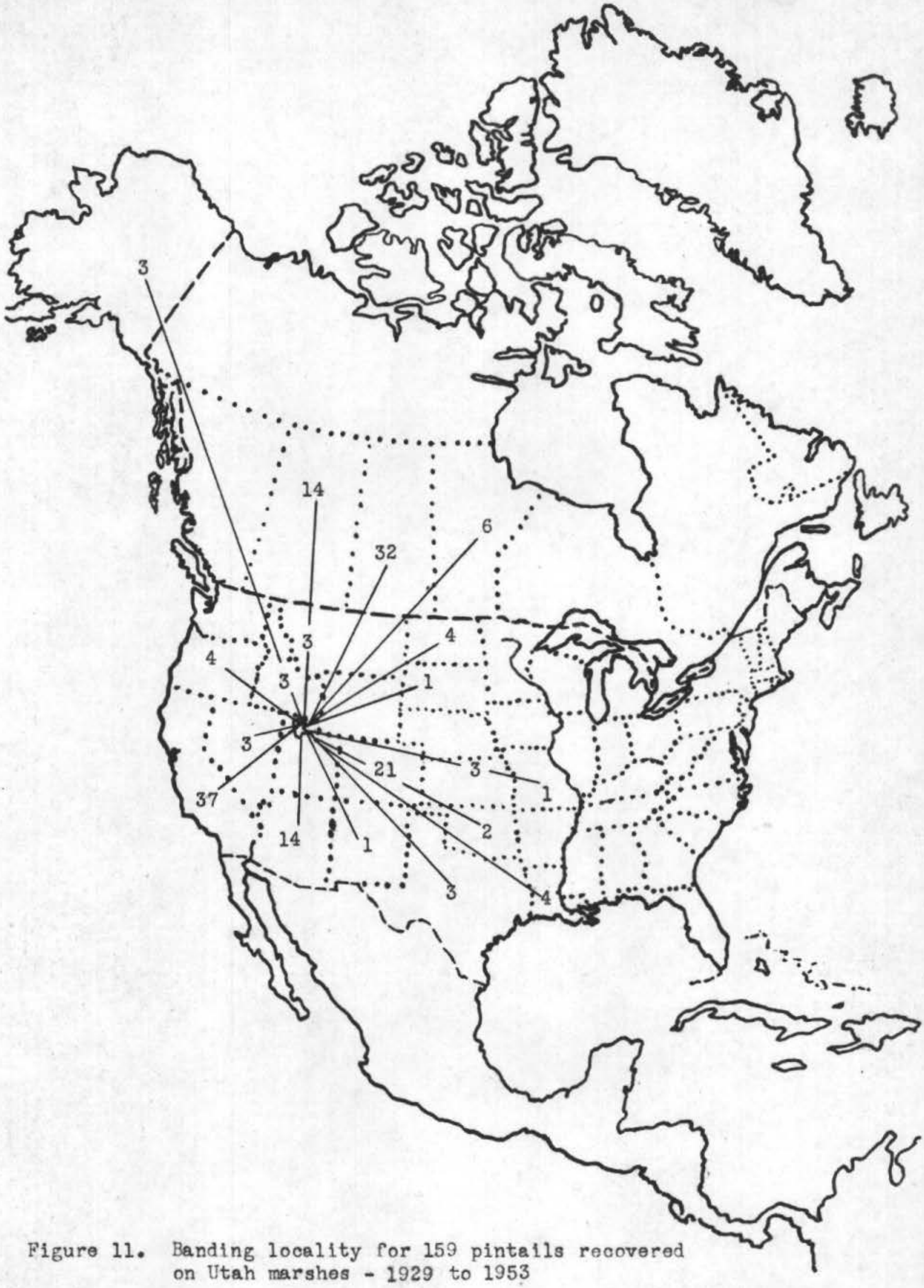


Figure 11. Banding locality for 159 pintails recovered on Utah marshes - 1929 to 1953

prairie provinces. Alaskan pintails recovered in Utah undoubtedly followed such a route. The distribution of out-of-state bands recovered in Utah is shown in Figure 11.

Contrary to Kortright's (1943, p. 51) remark that Bear River marshes have "furnished almost no recovery records of birds banded in Canada," the number of recoveries from Canadian banding in recent years has exceeded that of any single state in the United States. Low's (1949) data and that of Cartwright and Law (1952) show a strong trend to the Pacific for pintails banded as far east as Manitoba and North Dakota.

A total of 888 pintails was banded by the writer, 521 in 1951 and 367 in 1952. With the exception of 23 females banded on the nest, all banding was done from July to October of both years. Of the 12 first-year out-of-state returns, 3 were from Texas, 2 from New Mexico, 2 from California, and 1 each from Kansas, Arizona, Saskatchewan, South Dakota and Louisiana. A breakdown of the first year returns revealed that 10 were also direct returns of interest: 2 were from New Mexico, 1 from Arizona, 3 from Texas, 1 from Kansas, and 1 from Louisiana, indicating the possibility of a direct cross-country movement toward the Gulf coast; 1 was from South Dakota, a reverse fall movement; the remaining 1 was from California. The 3 second year returns were from Nevada, New Mexico, and Texas.

Returns from Utah-banded pintails in the period 1949 to February, 1953, are added to the data of Van Den Akker and Wilson in Table 8 and the location of returns is illustrated in Figure 10.

Of particular interest in Figures 10 and 11 is the high percentage of birds coming from the prairie provinces, Alberta, Saskatchewan, and Manitoba. It is likewise of interest to note the high percentage of

Table 9. Comparison of pintail sex ratios from various areas in the United States and Canada (Modified from Petrides, 1944)

Method, source and season	Sex ratio (M:F)
Banding	
Lincoln (1932), U. S.	168:100
McIlhenny (1940), La., winter	198:100
Hodge (Petrides, 1944), D. C., winter	172:100
Munro (1944), B. C.	52:100
Fuller, Utah, late summer, 1951	163:100
Hunters	
Hochbaum (1939), Man., fall	40:100
Fuller, Utah, fall, 1951	143:100
Field counts	
Furniss (1938), Sask., spring	190:100
~~Erickson (1943), Minn., spring~~	116:100
Petrides (1944), D. C., winter	126:100
Fuller, Utah, spring, 1952	136:100

Table 10. Sex and age ratios from a sample of botulism afflicted pintails in the Salt Lake Valley - 1951 and 1952

(a) Sick birds only

Period	Sample Size		Adults				Immatures				Age Ratio (A:I)		Sex Ratio (M:F)	
			Male		Female		Male		Female					
	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952
8/1 -15	---	115	---	39	---	5	---	39	---	32	----	62:100	----	211:100
8/16-31	163	779	67	252	13	113	53	210	30	204	96:100	88:100	278:100	146:100
9/1 -15	222	---	100	---	35	---	49	---	38	---	155:100	----	204:100	----
9/16-30	160	---	99	---	25	---	29	---	7	---	344:100	----	400:100	----
Season	545	894	266	291	73	118	131	249	75	236	165:100	84:100	268:100	152:100

(b) Dead birds only

Period	Sample Size		Adults				Immatures				Age Ratio (A:I)		Sex Ratio (M:F)	
			Male		Female		Male		Female					
	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952
8/1 -15	---	172	---	69	---	29	---	40	---	34	----	132:100	----	173:100
8/16-31	234	1084	82	359	11	188	82	335	59	202	66:100	102:100	234:100	178:100
9/1 -15	1128	752	559	478	169	104	229	145	171	25	182:100	342:100	232:100	484:100
9/16-30	1554	604	885	411	276	83	266	78	127	32	281:100	448:100	285:100	426:100
10/1-15	317	---	232	---	39	---	33	---	13	---	590:100	----	510:100	----
Season	3233	2612	1758	1317	495	404	610	598	370	293	230:100	193:100	274:100	273:100

(c) All birds handled

Period	Sample Size		Adults				Immatures				Age Ratio (A:I)		Sex Ratio (M:F)	
			Male		Female		Male		Female					
	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952
8/1 -15	---	287	---	108	---	34	---	79	---	66	----	98:100	----	187:100
8/16-31	397	1863	149	611	24	301	135	545	89	406	77:100	96:100	252:100	163:100
9/1 -15	1350	752	659	478	204	104	278	145	209	25	177:100	342:100	227:100	483:100
9/16-30	1714	604	984	411	301	83	295	78	134	32	300:100	449:100	294:100	426:100
10/1-15	317	---	232	---	39	---	33	---	13	---	590:100	----	510:100	----
Season	3778	3506	2024	1608	568	522	741	847	445	529	219:100	154:100	273:100	233:100

Table 11. Summary of pintails trapped and banded at Ogden Bay Refuge - 1951 and 1952

Period	Sample Size		Adults Male		Adults Female		Immatures Male		Immatures Female		Age Ratio (A:I)		Sex Ratio (M:F)	
	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952
7/15-31	1	16	0	14	0	0	0	0	1	2	----	----	----	----
8/ 1-15	7	42	2	24	0	0	2	13	3	5	40:100	133:100	133:100	740:100
8/16-31	158	148	9	46	11	12	78	76	60	14	15:100	64:100	122:100	470:100
9/ 1-15	238	84	63	47	28	9	85	16	62	12	62:100	200:100	164:100	300:100
9/16-30	81	44	48	33	15	2	9	4	9	5	350:100	389:100	238:100	530:100
10/1-15	27	0	21	0	6	0	0	0	0	0	----	----	----	----
Season	512	334	143	164	60	23	174	109	135	38	66:100	119:100	163:100	440:100

Table 12. Sex and age ratios from combined data of banding and botulism pickup

Period	Sample Size		Adults Male		Adults Female		Immatures Male		Immatures Female		Age Ratio (A:I)		Sex Ratio (M:F)	
	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952
8/ 1-15	7	329	2	132	---	34	2	92	3	71	40:100	102:100	133:100	213:100
8/16-31	555	2011	158	657	35	313	213	621	149	420	53:100	93:100	202:100	174:100
9/ 1-15	1588	836	722	525	232	113	363	161	271	37	150:100	322:100	216:100	457:100
9/16-30	1795	648	1032	444	316	85	304	82	143	37	301:100	444:100	291:100	432:100
10/1-15	344	---	253	---	45	---	33	---	13	---	649:100	----	493:100	----
Season	4289	3824	2167	1758	628	545	915	956	579	565	187:100	152:100	255:100	244:100

Table 13. Comparison of sex and age ratios from pintails banded and those picked up during the botulism seasons - 1951 and 1952

	1951				1952			
	Age Ratio (A:I)		Sex Ratio (M:F)		Age Ratio (A:I)		Sex Ratio (M:F)	
Period	Botulism	Banding	Botulism	Banding	Botulism	Banding	Botulism	Banding
Aug. 1					62:100		211:100	
to					132:100		173:100	
Aug. 15		40:100		133:100	98:100	133:100	187:100	740:100
Aug. 16	96:100*		278:100		88:100		146:100	
to	66:100*		234:100		102:100		178:100	
Aug. 31	77:100*	15:100	252:100	122:100	96:100	64:100	163:100	470:100
Sept. 1	155:100		204:100		-----		-----	
to	182:100		232:100		342:100		484:100	
Sept. 15	177:100	62:100	227:100	164:100	342:100	200:100	484:100	300:100
Sept. 16	344:100		400:100		-----		-----	
to	281:100		285:100		448:100		426:100	
Sept. 30	300:100	350:100	294:100	238:100	448:100	389:100	426:100	530:100
Oct. 1	-----		-----					
to	590:100		510:100					
Oct. 15	590:100		510:100					
	165:100		268:100		84:100		152:100	
Season	230:100		274:100		193:100		273:100	
	219:100	66:100	273:100	163:100	154:100	119:100	233:100	440:100

* Upper figure, sick birds; middle figure, dead birds; lower figure, all birds handled.

Table 14. Pintail sex and age ratios from a sample of the hunters' bag at Ogden Bay Refuge - 1951 and 1952

	Sample Size		Adults				Immatures				Age Ratio (A:I)		Sex Ratio (M:F)	
			Male		Female		Male		Female					
Period	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952
10/ 1-15	51	0	21	0	16	0	7	0	7	0	264:100		122:100	
10/16-31	904	240	385	79	267	84	145	47	107	30	259:100	212:100	142:100	110:100
11/ 1-15	420	218	196	104	150	65	46	27	28	22	468:100	345:100	136:100	150:100
11/16-30	280	265	148	151	97	75	23	16	12	23	700:100	580:100	157:100	170:100
12/ 1-15	148	134	81	80	52	26	11	14	4	14	887:100	378:100	164:100	235:100
12/16-31	0	10	0	5	0	4	0	1	0	0		900:100		150:100
Season	1803	867	831	419	582	254	232	105	158	89	357:100	344:100	143:100	152:100

Table 15. Comparison of pintail sex and age ratios from a sample of the hunters' bag at Ogden Bay Refuge (Data from Nelson, 1952)

	1946	1947	1948	1949	1950	1951	1952
Age Ratios (A:I)	118:100	70:100	110:100	196:100	127:100	357:100	344:100
Sex Ratios (M:F)	-----	73:100	68:100	143:100	111:100	143:100	152:100

California-banded pintails recovered in Utah along with 3 from Alaska, since Low (1949) indicates that Alaska is the principle breeding ground of pintails banded in California.

Mann (1950) reported a mass movement of waterfowl from the Lower Souris Refuge in North Dakota which constituted a reverse fall migration. Such a mass movement was never observed by the writer among pintails in Utah. The following 6 band returns indicated that reverse migration did occur although the magnitude of such movement remained unknown during the study:

Banded in	Recovered in
Utah, 9-25-40	Idaho, 11-6-40
Utah, 8-28-44	Illinois, 9-11-44
Utah, 9-19-51	S. Dakota, 10-16-51
Utah, 9-26-51	Idaho, 10-21-51
Utah, 8-21-52	S. Dakota, 11-1-52
California, 9-11-51	Utah, 10-12-51

In conclusion, the following isolated records are of interest:

1. A pintail was shot at Bear River Refuge where it was banded 10 years earlier.

2. A pintail taken at Galovin, Alaska, was banded 11 years earlier at Bear River Refuge, Utah.

3. A pintail banded at Bear River Refuge in 1929 flew into a wire in Canada on May 2, 1930, indicating the early presence there of a Utah-banded bird.

4. A pintail banded at Jet, Oklahoma, on February 21, 1952, was retaken at Bear River Refuge on November 2, 1952, which supported Low's (1949) "round-robin" theory.

5. A locally raised pintail, banded at Ogden Bay Refuge in 1951 by the writer, was shot in California that fall indicating that birds raised in Utah are not necessarily harvested by Utah gunners.

Discussion

(Early records and reports of nationally unbalanced sex ratios are probably unjustified in view of existing evidence of differential sex migration.) To properly analyze such a situation, widespread sampling of pintails on their wintering grounds just before spring migration when sexes are distinguishable would undoubtedly give the best results. Neither an accumulation of data from several seasons in a given area (such as that collected at Ogden Bay) nor a geographic distribution of data from various seasons other than winter can be extended to the population as a whole (Table 9); the possibility of variation in route of migration as well as in the element of time precludes this. On the wintering grounds, however, such considerations presumably would be unnecessary.

(A study of sex and age ratios reveals valuable data regarding the effect of losses upon the population. If males were consistently and universally predominant in losses from epidemics and hunting, the result would certainly be detrimental to a presumably monogamous species; heavy losses among females would be equally serious.) Information of this sort, in conjunction with a better understanding of differential migration, is important to the formulation of hunting regulations and the perpetuation of the resource. Studies of the individual species which are extensive in scope and intensive in nature appear well-founded in this light.

WINTERING GROUND STUDIES

Scope

Wintering ground studies began in December, 1951, after the close of the hunting season and continued until March of the following year at which time migration was under way. This phase of the study consisted of weekly and bi-monthly observations to determine population levels and factors affecting them, sex ratios on Utah wintering grounds, what areas were utilized, and to learn something of movements and activities. Observations were limited to northern Salt Lake Valley and Cache County.

Unless indicated otherwise in the table which follows, the data for Salt Lake Valley were collected at Farmington Bay Refuge, Ogden Bay Refuge, Bear River Refuge, Public Shooting Grounds, and some of the farmland surrounding these areas; in Cache County observations were made in Logan Canyon, on the Little Bear River, at Logan Fish Hatchery Ponds, and along the Bear River. Very little open water was to be found in these areas through most of the winter; warm springs and open sections of river attracted the birds.

Population levels

Two facts are inferred from Table 16: (1) the population is comparatively large at times in spite of the small amount of open water and severity of the winter, and (2) the population fluctuates considerably during the winter. Part of the reason for the variation in numbers appears evident and is discussed below under "movements and areas utilized." At no time could the writer say with certainty that variation in numbers was related to the prevailing weather.

Limited observations in the winter of 1952 and 1953 showed a sharp

Figure 12. A portion of Ogden Bay Bird Refuge in February, 1952. Rarely, until March of this year, did the accumulation of snow in this area exceed the amount indicated above.

Figure 13. A concentration of wintering pintails and mallards leaving a channel bank at Ogden Bay Refuge - February, 1952

Figure 14. A section of the channel bank on which the above birds had been loafing

contrast in populations as compared to those of the previous winter. In spite of a very open and rather mild season, very few birds were found on any of the above areas through the latter half of December and most of January. During 2 checks of Cache Valley areas in January, 1953, only 2 pintails were seen; a comparable situation existed in Salt Lake Valley. Late in January, however, pintails and other species began to appear in some numbers. Bear River Refuge recorded 200 pintails on January 15 and 4,200 on January 30. Similar numbers appeared at Ogden Bay Refuge.

Sex ratios

(Paired birds were evident in small numbers late in December. A rather consistent decrease in the ratio of males to females throughout the winter indicated a gradual readjustment in the composition on the Utah wintering grounds.) Although pre-nuptial courtship was occasionally witnessed, no increase in its tempo or incidence was noted until the middle of February. The number of paired birds increased from this time on.

Movements and areas utilized

From all indications movements during the winter were as varied and unpredictable as at other seasons of the year exclusive of the hunting season. They did appear to involve group movements to a greater extent than usual; however, this may have been due to the fact that the same kind of group movement was obscured at other seasons by greater numbers. In Cache Valley the only movement noted was between Logan Canyon and the ponds adjacent to the fish hatchery west of Logan City. When not feeding the birds spent the hours idly, preening and loafing on the ice or banks at the edge of the water. If disturbed in the canyon the birds moved to

Table 16. Pintail populations and sex ratios on 2 Utah wintering grounds

Date	Male	Female	Unclass.	Total	Sex Ratio
(a) Cache Valley					
12-21-51	100	49		149	204:100
1- 8-52	253	87	85	425	291:100
1-20-52	27	17		44	159:100
2- 4-52	4	3		7	133:100
2-20-52	19	18		37	105:100
3-10-52	166	118	1000	1284	141:100
(b) Salt Lake Valley					
1- 1-52	913	233	75	1221	392:100
1- 6-52	6	2		8*	300:100
1-13-52	38	22		60	173:100
1-19-52	15	9		24*	167:100
1-30-52			1825	1825	
2- 3-52	459	161		620	285:100
2-10-52	475	360		835**	132:100
2-15-52	488	426	10791	11705	115:100
2-24-52	231	206		437*	112:100
2-28-52	1571	1429	7339	10339	110:100

* Ogden Bay Refuge only
** Ogden Bay Refuge only and not a complete census

the hatchery ponds and vice versa.

In Salt Lake Valley similar activities were noted but pintails were less restricted in their movements. Very little snow accumulated during the winter in the lowlands of this valley (Figure 12) and concentrations of birds were frequently found in some field around a puddle of water. On February 16, 1952, a flock of some 2,000 pintails was seen in such a field near the village of Kanesville, Utah, and several flocks of 10 to 30 birds were seen flying over fields about 4 miles west of North Ogden.

On Ogden Bay Refuge only the main channels carried open water during the winter and birds were usually found along their banks, frequently massed together in so small an area that it was impossible for all to take wing immediately when disturbed. Considerable shuttling about from one area to another was often the cause of the variation in numbers noted in Table 16.

Discussion

A possible explanation of the variation in wintering populations from 1 year to another occurred to the writer during the latter part of the 1952 hunting season. In the first place, the 1952 hunting season extended 2 calendar weeks beyond that of 1951. Secondly, when late November and December migrants reached Utah in 1952 they encountered not only marshes that were almost completely iced over but also hunters waiting on much of the open water to be found. Under such conditions, it seemed likely that the sleek "greyhounds of the air" funneled through the state rapidly in search of happier circumstances. In 1951, this rear echelon of the fall migration found more snow in Utah but, of greater importance, few or no hunters and plenty of open water.

The change in sex ratios in 1951 indicated that considerable movement in and out of Utah during the winter must occur. Radical changes noted in species composition through the winter gave additional credence to this theory. Moderating weather in late December of 1952 and in January of 1953 opened much of the water in the latter month which was frozen at the close of 1952; movement of the above type would serve to bring birds to Utah once the water was open. It is equally possible that the unusually warm weather experienced in January of 1953 was influential in precipitating moderate and early northward migration.

One further possible explanation of variation in numbers during a given winter revolves around the food supply. In very local areas such as Logan Canyon it is conceivable that a large number of birds on a limited stretch of open river could quickly exhaust the available food. The carrying capacity of such an area is undoubtedly lower than an equal area of marsh in the valley.

Generally speaking, then, it can be stated that northern Utah serves as a wintering ground for a number of pintails except in very severe weather. There is some evidence at least that the amount of open water available to the birds governs the size of the population more than does the amount of snow or any direct effects of temperature on the birds.

COURTSHIP AND MATING

Courtship behavior

The courtship of the pintail is probably less frequently observed in Utah than that of any other duck which breeds here in comparable numbers. Since the majority of the females arriving in the spring appear to have chosen their mates, courtship and pairing must occur on the wintering grounds or during migration. That this does occur as early as late December and throughout January was positively determined by observations on pintails wintering in Utah through the winter of 1951-52.

Other factors contribute to the low incidence of courtship observations, not the least of which is the alertness of the pintail; on countless occasions throughout the year the writer has observed that pintails are most frequently the first to become aware of an intruder and to take wing. In addition to this, the courtship time is short, displays are brief, and few of its manifestations take place after pairing. Finally, the observer must expect a repertoire quite unlike that of most courting waterfowl.

To this writer, the most outstanding feature of pintail courtship is the lack of hostility between males. Never has he seen a male, mated or unmated, thrust at or in any way actively attempt to repel a competitor. As described by Bent (1951, p. 145) 2 or more drakes may be seen crowding their attentions on a single female, each standing erect on the water and "displaying his snowy breast with his long neck doubled in graceful curves" and his tail pointed upward. Even this was rarely seen, however. Courtship consists largely of aerial chases which, although usually lasting but 2 or 3 minutes, are amazing in their speed and sinuous course of flight. The female frequently parades before a male, neck extended low to the ground, uttering a sharp quack; this succeeds in attracting 1 or 2 males to follow her, whereupon she immediately takes to the air followed by her admirers. The path of flight is usually low at first which appears to invite the pursuit of additional males. The writer has seen a group of pursuing males overtake a female in this flight only to have her veer upward or to one side so swiftly that she was lost to them momentarily. Very frequently a lone male will succeed in outmaneuvering the others momentarily or will do so consistently until his competitors appear to lose interest and drop back to the ground. When this occurs the female likewise seems to tire of the chase and the flight is quickly terminated.

In some instances the remaining drake and hen have been observed to segregate themselves from other birds by alighting in a secluded channel; distance and the nature of the vegetation always concealed the pair from the observer in these instances, but it is suspected that copulation may have followed the stimulation of the chase. Actual copulation between pintails was never observed.

Mating habits

From the time of pairing and arrival on the breeding grounds to the beginning of incubation, pintails spend many hours of each day idly resting and preening. Edges of shallow, open sloughs and the saltgrass borders of such sloughs at Ogden Bay Refuge are favored areas for this pastime as are the shallow lakes in the area. Displays are much more rare between mates, only a close companionship identifying the sexual relationship.

Technically, use of the word "paired" or "mated" is questioned by the writer in reference to the pintail. Too frequent to be considered accidental was the observation of 2 drakes attending a female or joining a female flushed from her nest. The perpetual lack of aggressiveness among males only aggravated the conceived doubt over the monogamy of this species. Kortright (1943, p. 219) allocates 2 husbands to the female shoveller and acknowledges an occasional case of polyandry among mallards, although the latter species is characterized by jealous "flares between the marital partners." Strict monogamy among waterfowl was also questioned by Leopold (1946, p. 104) who wrote:

> The mating of wild ducks is still an enigma. Job (1923) says "ducks in wild state are normally monogamous . . . but tend to become polygamous in captivity." Grinnell (1918) says of the mallard, "this duck is monogamous in its native estate, although some authorities contend that polygamy occurs where there is a dearth of males." It seems likely that monogamy is normal for all the ducks when the sexes are balanced. Where unbalanced, the excess is likely to be of males (Lincoln, 1932). Promiscuity, or even polyandry, might be looked for under such conditions.

Attempts to qualify the mating habits of pintails were unsuccessful. Factual data were never obtained nor was specific reference to this question encountered in the literature on pintails. Sex ratios (Figure 9), though favoring males, are not qualitative and additional research on this topic is needed.

Interspecific relationships

Pintails outnumber any other single species in this area during the peak of the spring migration but, in turn, are outnumbered by others in the resident population. Under either circumstance there appears to be a complete compatability among the species during courtship and mating activities.

No instances of interspecies partners, which would result in hybrids, were ever observed. Occasionally an excited cinnamon teal has been known to momentarily join a pintail courtship flight, and on at least 2 occasions a male pintail has been seen rising to join a group of courting gadwalls. In all such cases, however, the "outsider" quickly left the chase. No other type of interspecies courtship was ever observed.

NEST SITE SELECTION AND TERRITORIALISM

Nest site selection

Quite frequently during nest-hunting activities, female pintails were observed flushing from the vegetation when their presence had previously been undetected. When an intensive search of the area from which the female had flushed revealed no nest (ordinarily not too difficult to find) these instances were interpreted as being an attempt on the part of the female to select a nest site. Drakes apparently took no active part in the search, but joined the female immediately in flight or preceded her in flushing. In 2 cases where the writer observed this search from its beginning, the males remained behind on the bank of a borrow pit while the females meandered through the vegetation, at times being 200 yards from their mates.

Data on the proximity of nest and territory were very limited. During the study only 14 instances of a hen joining a drake upon flushing from the nest were recorded. In all such cases, the drake was waiting at the edge of a shallowly-flooded alkali flat, frequently sitting in the edge of the vegetation out of sight and joining the female on the water as she descended. The distance from nest to territory varied from 35 feet to 350 yards.

Territory: utilization, defense, and tenure

An intrinsic feature of a territory as an ornithological concept and explained by Hochbaum (1944) is the active defense of the area by the drake against intruders. A rather interesting fact, the complete absence of antagonism between drake pintails during this study, necessitates the modification of this concept but not its elimination. Unless otherwise specified, all reference to pintail territory in this work means an area on which the drake awaits the return of his mate from her egg-laying or incubating activities. It is also utilized by the pair as a resting or "loafing" area and a feeding area.

It was common for more than 1 species to utilize the same area for a territory and equally common to observe excess male pintails on an area serving as a territory for a pair of mated pintails. Several records exist in the writer's field notes wherein the same territory was utilized simultaneously by 2 pairs of pintails with no apparent friction between the drakes. Munro (1944) reported similar observations in British Columbia. He noted a lack of competition for territories and instances of several pair using the same area with hostility not exhibited by the males; males also tended to associate while awaiting the return of their mates and fraternizing increased toward the end of egg-laying and the beginning of incubation.

The belief was expressed by Bent (1951) that the male did not wholly desert the female during incubation. In all but 2 of the cases of observed territorality, the males deserted their mates and territories by the end of the first week of incubation. Of the remaining cases, the identity of 1 pair was lost when the nest was destroyed by gulls and the pair presumably moved elsewhere; the drake of the second pair was seen much less regularly on the territory during the first week of incubation but did not desert the area completely until the end of the second week of incubation. Other writers have indicated an early desertion on the part of the male (Munro, 1944; Cottam, 1947).

The female continues to use the area for occasional resting and

Figure 15. Willow nest markers in a community of weeds at Ogden Bay Refuge. The distance between nests marked by these poles was approximately 25 feet.

feeding; except for late incubation periods when feigning may be employed, this same area is usually resorted to when the female is flushed from her nest.

Discussion

Acknowledging rather limited observations, females alone appear to select the nest site while the male plays the part of sentinel.

In view of a well-interspersed marsh which provides a multiplicity of territories, and an uncrowded breeding population of pintails, it is considered doubtful if the nest site and territory are ever more widely separated on this area than the maximum distance observed during this study.

It is suggested that by virtue of the size of the breeding population in Salt Lake Valley a lower degree of intraspecies competition exists among pintails than other species, and that this may partially explain the lack of antagonism between males. In addition, the apparent early desertion of female and territory on the part of the male probably accounts for the low incidence of observed territorality.

THE NESTING SURVEY

Methods of procedure

A nesting survey was conducted during both years of the study although a greater amount of time and effort was devoted to this phase in 1952 than in 1951.

Sowls (1949 and 1950) has described several methods of locating waterfowl nests and some of his techniques or modifications thereof were applied in this survey. By far the best results accrued from the method of walking in the area and flushing hens from their nests. The study area was searched by traversing a strip in a westerly direction and returning in the opposite direction on an adjoining strip. Proceeding in this manner, several days were required to cover the area from its northern to its southern boundary, inasmuch as the entire day was never devoted entirely to nest-hunting. The width of the strip covered at any one time varied considerably, always being narrower when the writer travelled alone, time allocated for the search was limited, windy weather prevailed, or some feature of the terrain or vegetation thereby facilitated the search or made a narrow strip mandatory. As soon as the study area had been completely covered the search began anew and proceeded as in the previous coverage.

Several factors, not emphasized by Sowls, appear to contribute to the success of this method of locating nests: (1) a willow shoot 8 to 10 feet long (preferably branched and dry) used to flay the vegetation around the searcher frequently flushed hens which otherwise remained on the nest; this was found applicable to some teal during the egg-laying period and to all species exhibiting an increased attachment to the nest as incubation progressed; (2) the number of nests located in a given area and time interval appeared directly related to the numbers of searchers but with something greater than a direct proportion involved; (3) time spent in a given location also appeared directly related to the number of nests found; frequently in lingering at a nest to record observations the writer has seen a hen flush from a nearby nest that was by-passed a few minutes earlier and has termed this a "delayed flush," i.e., brought about by the passage of an intruder but delayed until the "danger" has passed and presumably left the area, or brought about from frustration over the delayed presence of an intruder; (4) frequent change in direction of movement to avoid prolonged straight courses increased the success of locating nests; hens on nests which had been located on previous visits were observed to remain motionless and permit passage within 1 or 2 feet if the writer advanced and maintained a straight line of walk, whereas, a sudden turn directly toward the nest or a return path close to the nest caused the hen to flush.

A second technique found useful under certain conditions was that of noting a lone male waiting on his territory and searching the adjacent cover to locate his mate (Hochbaum, 1944). It is obvious that this method is applicable only until drakes desert their mates and territories, and that the point of diminishing returns would quickly be reached in those cases where nesting site and territory were widely separated.

The third method of locating nests involved the use of flushing rods attached to the front bumper of a truck. Two stout willow poles about 10 feet in length were wired in place, 1 pole projecting beyond each side of the truck and having some freedom of vertical movement; this permitted the poles to follow the contour of the vegetation on the dike banks as the truck advanced. Driving slowly along the dikes with the poles dragging in the vegetation proved a particularly successful method in densely vegetated areas.

Having found a nest, its position was marked on an aerial photograph of the area and it was located for subsequent visits by "flagging" with a long willow shoot. Each willow was stuck in the ground in an upright position at a distance of 6 paces from the nest and in line with a mountain peak east of the refuge. Data for each nest were recorded on a separate nest history form. Each nest was coded by species and the designation recorded both on the form and the willow at the nest. e.g., P-5 indicated pintail nest number 5, M-9 denoted mallard nest number 9.

Nest concealment was recorded as "excellent" for nests which were completely hidden from the observer on all sides and from above, "good" for those which were hidden from lateral observation but exposed from above, "fair" if the nest was exposed from above and only partially concealed from lateral observation, and "poor" if it was completely exposed.

Down was classified as "heavy" when a thick roll completely encircled the bowl or covered the eggs, "medium" when a thin roll completely encircled the bowl but would not completely cover the eggs, "light" for traces and patches or incomplete rolls, and "absent".

Distances to the nearest water were measured by pacing and the nature of the water noted as to shallow-open slough, weed-filled ditch, deep channel, etc.

With a millimeter rule, nests were measured for maximum depth of bowl, diameter of the inner rim, and diameter of the outer rim. Egg dimensions were taken with a metal calipers to obtain maximum length and breadth.

Under the above methods of locating nests, re-visits were made every 4 to 6 days; in the case of pintail nests, many were re-visited every day to determine rate of egg-laying, initiation of incubation, and incubation period. All other nests were re-visited at least every fourth day in the final stages of incubation to obtain reasonably accurate hatching dates.

Data were recorded on the cover type in which individual nests were located. During the summers of 1951 and 1952, a type map of the special study area was completed (Figure 18). An outline map (scale 1 inch to 150 feet) was first drawn from an aerial photograph of the area; then, beginning at the north side of the area, 150 feet intervals were marked off along the eastern and western boundaries by placing willows flagged with strips of white cloth on the dikes; by travelling east and west between flags and pacing distances, cover type boundaries were plotted on a tracing of the outline map and then transferred indoors to the map itself. Details of the perimeter of the area were sketched in by observation from the top of a truck's cab. A planimeter was used to determine the total area and the area of individual types.

At all times when working in the area an attempt was made to keep human interference at a minimum. Vegetation was disturbed as little as possible, particularly at the nest site; flagging poles were set at some distance from the nest; eggs were always covered before departing. Gulls were always present in the area, many of them developing the habit of following the observer through the marsh; at such times an effort was made to drive the gull away and at no time was a nest visited when a gull hovered in the immediate vicinity.

Phenological aspects

1951 Season. Unusually warm weather prevailed in January and February and large numbers of birds wintered in Salt Lake Valley. Spring came early to this area but was considered cool from March until July. The last spring frost in the Ogden Bay area occurred on April 12, although the lowest daily average for that month was 38 degrees on April 30.

Negligible precipitation resulted in a rather dry season as well as a cool one. Total precipitation in April amounted to 3.74 inches and that in May amounted to 1.60 inches; less than 3/4 of an inch was accumulated in either March, June or July. The last spring snow (2.5 inches) fell on the Ogden area on April 30 and was the only snow of the month; even this proved to be ephemeral.

Although heavy snows accumulated in the mountains in the preceding winter, the runoff during this nesting season was gradual due to cool weather and lack of rain. As a result, flooding of the marshes and bottomland farm belt was less than anticipated. By the same token, the growth of vegetation was delayed on the nesting grounds. This was very likely responsible for some of the early predation on nests although the incidence of predation was not exceptional. The only other evidence indicating adverse effects of the weather consisted of the death of 4 downy coots (*Fulica americana*); these birds were found on the morning of June 2, 1951, on a muskrat house and, from all indications, had died of chilling. Field notes revealed that the previous 4 nights had been unusually cold. No similar losses were noted among ducks, and nesting conditions in general were considered exceptionally good.

1952 Season. Weather conditions during this season contrasted sharply

Figure 16. Location of nests on special study area at Ogden Bay Refuge - 1951

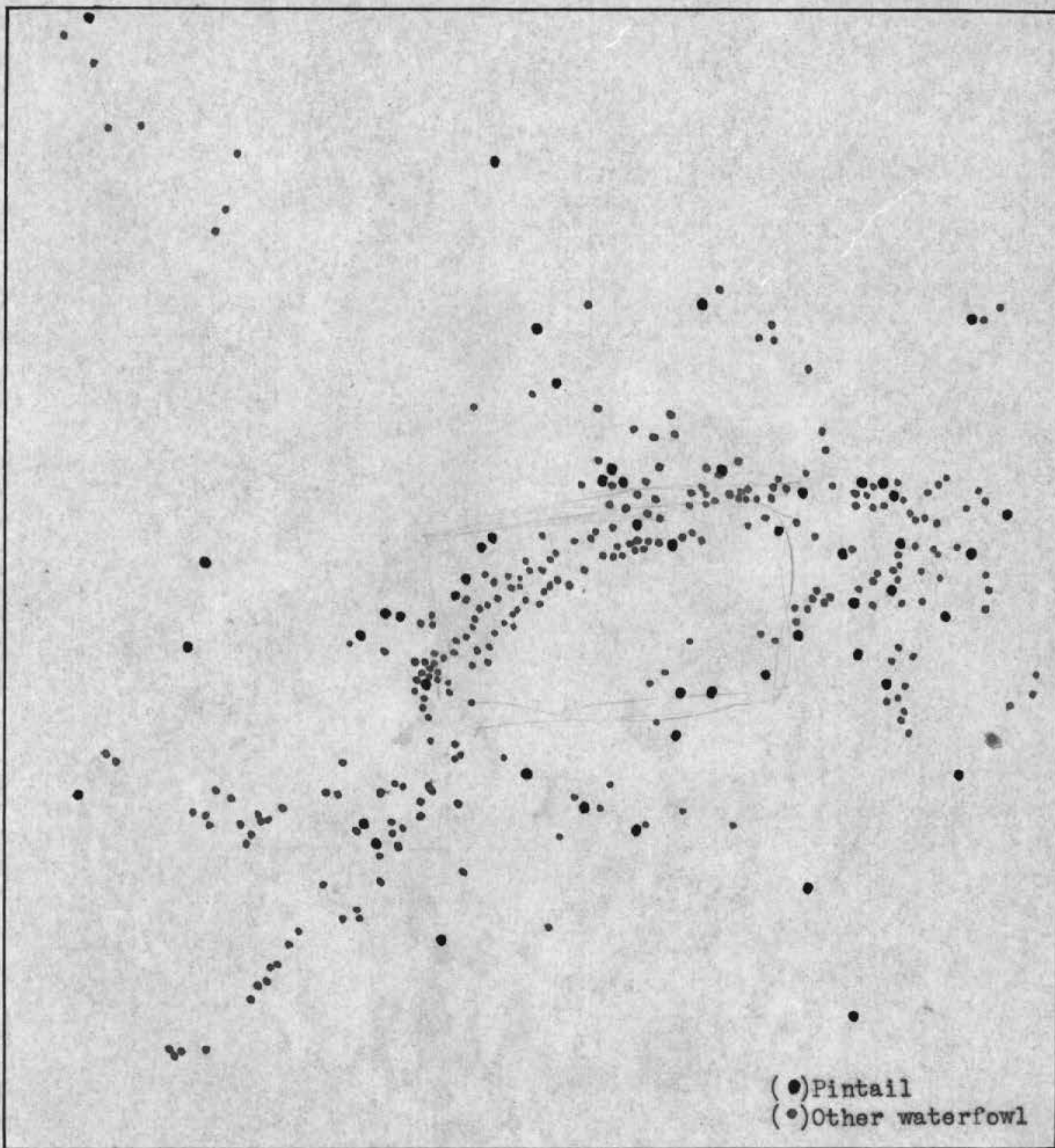


Figure 17. Location of nests on special study area at Ogden Bay Refuge - 1952

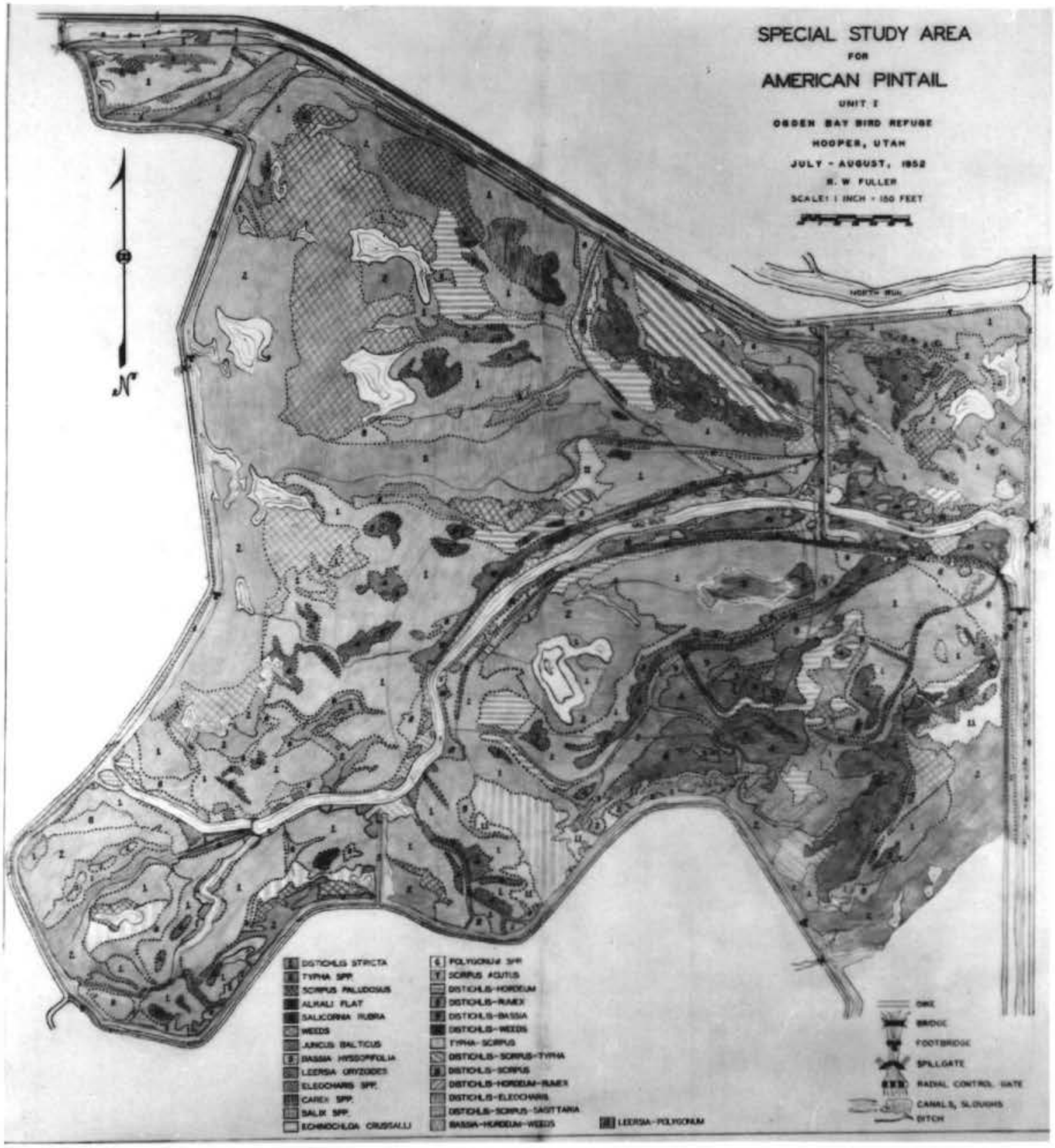


Figure 18. Cover type map of special study area at Ogden Bay Refuge

with those of 1951. February and March were unusually cold, January to a lesser extent. Very little open water was to be found in the northern part of the state and migration appeared somewhat retarded. The last frost occurred on April 9 after which the weather warmed quite rapidly. Even late in the season abrupt extremes in temperature were encountered, however; a considerable number of the earlier arriving avocets (Recurvirostra americana) succumbed to the unusual weather.

In addition to intense cold, March was spectacular by way of snowfall that exceeded all previous records for the month; in some areas the fall exceeded 200 per cent of the normal amount. The last heavy fall in the Ogden area came on March 24 (4.2 inches); a trace was recorded on April 2. Precipitation in the remainder of the nesting season, while seldom exceeding that of 1951 in total amount, was more frequent in occurrence.

Water levels began rising noticeably in late March, and warm April days precipitated widespread flooding in the valleys. Conditions on the refuges, where water could be controlled to some extent, were not serious. However, vast areas of surrounding farmland and pasture, normally acceptable nesting cover to pintails and some other ducks, were inundated until late in the season.

Nesting was probably delayed over much of the state. Canada Geese, normally nesting in late March, were faced with depositing their eggs in snow. Many of the early mallard and pintail nests outside of the refuges were undoubtedly flooded. The effects of flooding were not entirely on the debit side, however, since birds which had not begun laying early (and renesters) were forced to locate their nests on higher ground. This, and the fact that conditions were excellent after flood waters receded,

Table 17. Climatological data for Ogden Bay during the 1951 and 1952 nesting seasons (U. S. D. C., 1951 and 1952)

1951											1952									
March		April		May		June		July			March		April		May		June		July	
T*	P*	T	P	T	P	T	P	T	P	Date	T	P	T	P	T	P	T	P	T	P
30		47		42	.06	51	.01	71		1	30	.10	40		61		70		69	
31		46		49	.03	51		73		2	31	.05	42	.26	67		69		65	
27	.10	49		53		52		74		3	20		44		72		69		70	
32		54		63		59		76		4	26	.02	46		61		68		76	
34		55		63		65		73		5	30	.01	50		62		72		77	
35	.32	54		68		61		74		6	24		56		61		76	.03	74	
42	.18	51		56	.11	60		72		7	35		60		60		71		73	
42		50		53	.19	53		72		8	36		50		59	.14	72		72	
44		56		55		59		71		9	32		42		53		75		76	
26		49		61		59		68		10	35	.08	47		55		77		77	.01
28		42		61		60		67		11	34	.48	51		62		71		73	
32		47		51	.62	65		69		12	31		47		66		67		71	
38		54		43		64		75		13	26		51		69		66		67	
38		55		53		66		79		14	31	.14	44	.18	61		77		66	
47		54		54	.30	69		81		15	33	.02	47	.41	56		68		69	
40		53		55	.05	74		80		16	42	.06	48		49	.15	59		73	
27		56		58		73		80		17	37		52		57		69		73	
28		56		63	.08	69		84		18	51		67		57		73		74	
35		57	.05	64		68		81		19	33	.75	68	.05	61		76		75	
44		55	.04	62	.13	65		75		20	31	.30	54	.02	60	.22	68		66	
49		52		59	.03	67		72	.07	21	27		52		52	.07	67		72	
48		49		61		65	.01	73		22	22		51		47	.09	63		74	
34		65	.02	64		60		75		23	22	.02	55		56		67		78	
39		51	.90	65		69		78		24	37	.39	61		64		59	1.23	82	
45		57		65		68	.06	77		25	38	.04	62		65		62	.13	79	
47		49	.60	67		67		76		26	42		65		62		58	.04	82	
40		56	.15	72		67		77		27	41		66		63		60	.15	78	
34		57	.09	66		69		76	.66	28	44		63		66		67		78	
40		50	.82	63		69		74		29	46		58		69	.02	73		77	
48	.04	38	1.07	64		66		77		30	45		57		59		65		78	
45	.10			58				77		31	41	.06			68				77	

* T - average temperature (Fahrenheit); P - precipitation (inches)

was largely responsible for the degree of nesting success achieved in Salt Lake Valley for the year as a whole.

Daily temperatures and precipitation for the 1951 and 1952 nesting seasons are presented in Table 17. Monthly figures for the 2 complete years are included in the appendix.

Inter- and intraspecific relationships

Ogden bay Refuge provides nesting cover for the following species of waterfowl:

Canada Goose (*Branta canadensis*)
Common Mallard (*Anas p. platyrhynchos*)
American Pintail (*A. acuta tzitzihoa*)
Gadwall (*A. strepera*)
Shoveller (*Spatula clypeata*)
Cinnamon Teal (*A. c. cyanoptera*)
Redhead (*Aythya americana*)
Baldpate (*Mareca americana*)
Green-winged Teal (*Anas carolinensis*)
Blue-winged Teal (*A. discors*)
Ruddy Duck (*Oxyura jamaicensis rubida*)

Of this group, the baldpate and green-winged teal are rare nesters at Ogden Bay, as is the blue-winged teal in some years; sizeable breeding populations of the other species are noted annually. Nests of only the first 7 species were noted on the special study area in 1951 and 1952.

Tolerance. Observations indicated a variation in the interspersion of nests: a mallard nested within 10 inches of a Canada Goose; 1 pintail nested within 3 feet of a cinnamon teal, while pintails within 4 feet of other species were frequently noted; twice during the study all species except the Canada Goose were simultaneously represented on an area as small as one-tenth of an acre; not once during the 2 years of the study, however, were 2 pintails found occupying nests closer than 10 feet apart at the same time. This is not evident from Figures 16 and 17 which show the location of nests for the entire nesting seasons.

This brings attention to the question of whether or not pintails are intolerant of a certain nesting density. Is there a limit of density, a maximum number of nests per unit of area or vegetation? Leopold (1946, p. 56) in discussing nesting desities wrote:

> The apparent intolerance of continued concentration which is here called the saturation point probably becomes operative under some particular set of circumstances, or at some particular season. One might guess from Howard's concept of "territory" that it became operative during the breeding season. If so, the maximum density of nests ought to show it.

From facts then presented he argues that upland game birds may concentrate their nests during an emergency such as temporary loss of cover but that "the breeding season is evidently not the time when intolerance of concentration is most active." Although Leopold points out that waterfowl seem to concentrate their nests even more than gallinaceous birds, it seems doubtful that his conclusion applies in toto to waterfowl. Molting and wintering concentrations of pintails and other ducks would seem to indicate a greater compatability at periods other than the nesting season.

It was definitely obvious during the investigations at Ogden Bay that certain portions of the study area always contained a greater number of nests than did others. With reference to the vegetation, monotypes covering large areas consistently showed a lower density of nests than did either mixed stands of vegetation or numerous small patches and narrow strips of monotypes. Even when a number of nests were found in some extensive type they tended to be located near the periphery rather than the center of the stand.

A total of 270 nests located in 1951 and 322 in 1952 represented nesting densities of 0.56 nests per acre and 0.67 nests per acre, respectively, for the entire study area (482.43 acres). From a closely similar area at Ogden Bay in 1950, Spencer (1953) calculated a density of 0.5 nests per acre while Williams and Marshall (1938) reported an overall density of 0.80 nests per acre for Bear River Refuge. Considering only pintail nests on the study area, 39 nests in 1951 and 52 in 1952 represented respective densities of 0.08 and 0.11 nests per acre. Williams and Marshall (Ibid) found a density of 0.07 nests per acre for this species.

Table 19 presents pintail nesting by cover types and, by eliminating non-utilized area, shows densities of 0.14 and 0.15 nests per acre for the 2 successive years of this study. A closer agreement is, therefore, attained for these 2 years when this latter method of calculating densities is employed. Another point of interest from this table is that rushes (Juncus balticus), spikerushes (Eleocharis app.), and bassia (Bassia hyssopifolia) showed the 3 highest densities during both years of the study; the first 2 of these occurs chiefly along dike banks and higher ground as narrow strips of vegetation. (The highest density for any cover type was 1.75 nests per acre in bassia.) A similar breakdown for all species would show correspondingly increased densities.

It may be argued that these figures have no bearing on the tolerance of the pintail to any nesting density since the densities herein discussed are totals for the entire nesting season. Nevertheless, the density at any specific time in that season could not have exceeded the season total.

The nesting survey represents at best only a sample of nesting on the area; a more intensive search increasing the total number of nests located would increase density; counteracting this, density would tend to decrease as a more intensive search revealed the utilization of cover in which no nests were found during this study.

Hochbaum (1944) suggested for more widely separated areas that differences in density are attributable to a lack of suitable territories. It seems doubtful that such a hypothesis would pertain to so small a study area or even to Ogden Bay Refuge as a whole; territories there appear to be more than adequate for the breeding population.

These data, while inconclusive, suggest that a limit of tolerance does exist for the pintail. Other factors, as yet poorly understood in their relation to nest location, restrict the use of density as a criterion of tolerance. Among these factors are the effect of weather on nesting and plant growth, the effect of variation in rate of growth and development of vegetation of different types on nest site selection, the possibility of variation in preference for certain cover types, and the efficiency of the observer in locating nests in one cover type as compared to his efficiency in another type.

The writer proposes that a limit of tolerance exists for the pintail in the linear distance between nests, that this tolerance is greater for interspecies than between 2 pintails, and that it is a function of plant interspersion and "edge" effect. Assuming that no pintail will nest closer than 10 feet to another of the same species, for example, but that pintails occupy nests at every 10 feet on an acre of land, Figure 19 shows that as the perimeter ("edge") of an area increases, higher nesting densities under the above assumptions become possible. Interspersion creates "edge", and tolerance appears directly related to this property of cover. Although largely a hypothetical example, the above data and observations lend support to the theory and it seems worthy of additional study. It is probably rarely

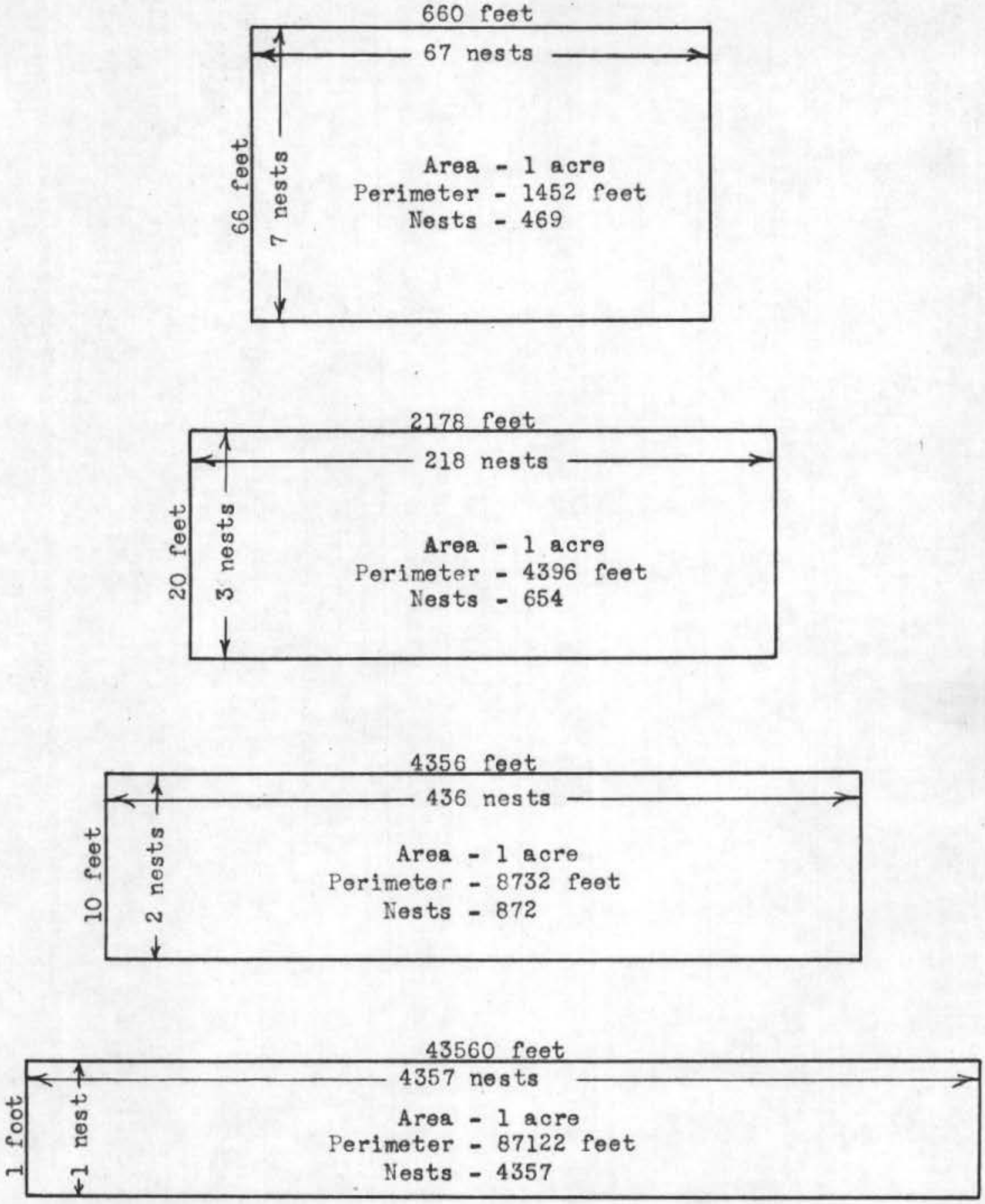


Figure 19. Theoretical variation in maximum nesting density on equal areas of varying perimeter ("edge"). All nests 10 feet distant from each other.

the case in nature that actual density of nests on an area approaches or equals the maximum possible on that area; this suggests the possibility of a complex interaction of factors even though a single factor may be limiting under specific conditions.

Utilization of cover

Pintail nesting and utilization of nesting cover have received attention by workers in this area in previous years. Williams and Marshall (1937 and 1938) found willows, hardstem bulrush, weeds, and cane, in the order named, to be preferred nesting cover at Bear River Refuge. Cottam (1947), discussing pintails in Utah, listed the order of preferred nesting cover as saltgrass, hardstem bulrush, willow thickets and alkali bulrush.

Interspersion. Some attention has already been given this subject under inter- and intraspecific associations. Figure 18 indicates the interspersion of cover types and of cover and water on the study area while Tables 18 and 19, and Figures 20 and 21 present some details of the availability and utilization of cover for nesting.

Three different methods of evaluating the importance of various cover types to nesting waterfowl are presented in Table 19 for purposes of comparison. Number of nests by cover types is very misleading and the least valuable of the 3 methods. An evaluation on the basis of density is a more equitable assessment of the cover since it compares the use of each cover type on the basis of an equal unit of area. A further refinement of the principle of density was utilized by Williams and Marshall (1938) and called the per cent acreage-use value. Their method is expressed algebraically as:

$$\text{P.A.-U.} = \frac{\text{Nests(a) in a Cover(z)/Total Nests(A)}}{\text{Area(b) in a Cover(z)/Total Area(B)}} \qquad \frac{az}{bz} \Big/ \frac{A}{B}$$

Only those cover types in which nests were located are shown in Table 19 which explains why the total acreage of this table does not equal that of Table 18. Percent acreage-use values are based on the acreage of the total vegetation on the area.

The variation in these values for the 2 years of the study requires some consideration. Variation in the 2 values for a given cover type is due to (1) a difference in the number of nests in that cover type, and (2) a difference in the total number of nests located each year.

Assuming that the samples were representative and that there was no variation in the efficiency of the searcher either in the 2 years or in different cover types, differences in the order of magnitude of P.A.-U. values were indicative of differences in relative importance of the cover types for these 2 years. Thus, in 1951, the order of importance of nesting cover was rushes, spikerushes, bassia, weeds, and saltgrass-weeds; in 1952, it changed to bassia, saltgrass-spikerush, rushes, weeds, and spikerush. In spite of the changes noted in the 2 years' data, the value of interspersion and edge effect was again indicated.

Relation of nests to water. None of the pintail nests on the study area was greatly distant from water. During the nesting season, however, there was no point on this area which was not within one-quarter of a mile of water and very few places were more distant than 200 yards from a ditch, a channel, or an inundated area. Specifically, the range for pintail nests was from 19 feet to 100 yards, the greatest number in any 1 class (21) being less than 6 feet from water (Table 20). Ninety-three and four-tenths percent of the 91 nests were within 100 feet of water. All 1951 nests were within 150 feet of water and 89.8 percent

Table 18. Key to cover types on the special study area, Ogden Bay Bird Refuge, Utah. 1951 and 1952.

Key No.	Cover Type	Acreage	Percent
1	Saltgrass	143.21	26.69
2	Cattail	83.77	17.36
3	Alkali Bulrush	44.22	9.17
4	Glasswort	21.27	4.41
5	Saltgrass-Dock	17.37	3.60
6	Saltgrass-Foxtail Barley	14.06	2.91
7	Weeds	13.90	2.88
8	Saltgrass-Weeds	13.75	2.85
9	Saltgrass-Bassia	8.81	1.83
10	Saltgrass-Alkali Bulrush-Cattail	7.20	1.49
11	Alkali Bulrush-Cattail	6.31	1.31
12	Bassia-Foxtail Barley-Weeds	5.29	1.10
13	Rushes	5.26	1.09
14	Saltgrass-Alkali Bulrush	4.76	0.99
15	Bassia	4.31	0.89
16	Rice Cut-grass	2.67	0.55
17	Spikerush	2.02	0.42
18	Rice Cut-grass-Persicaria	1.98	0.41
19	Hardstem Bulrush	1.32	0.27
20	Miscellaneous (less than 1.0 acres) Sedges 0.93, Willow 0.85, Saltgrass-Spikerush 0.80, Millet 0.61, Foxtail-Dock-Saltgrass 0.55, Duck potato 0.31, Persicaria 0.17 - - - - - - - - - - - - - -	4.22	0.87
21	Alkali Flat	28.02	5.81
22	Open Water	48.71	10.10
Totals		482.43	100.00

Table 19. Pintail utilization of nesting cover on the special study area at Ogden Bay Refuge

Cover type	Acreage	Number of Nests 1951	Number of Nests 1952	Nests per Acre 1951	Nests per Acre 1952	P.A.-U. Values* 1951	P.A.-U. Values* 1952
1 Saltgrass	143.21	8	18	0.06	0.13	0.58	0.98
2 Cattail	83.77	1	1	0.01	0.01	0.12	0.09
3 Alkali bulrush	44.22	0	1	----	0.02	----	0.18
5 Saltgrass-Dock	17.37	2	1	0.12	0.06	1.19	0.45
6 Saltgrass-Foxtail barley	14.06	0	2	----	0.14	----	1.11
7 Weeds	13.90	9	7	0.64	0.50	6.73	3.93
8 Saltgrass-Weeds	13.75	5	6	0.36	0.43	3.78	3.40
10 Saltgrass-Alkali bulrush-Cattail	7.20	0	1	----	0.14	----	1.08
12 Bassia-Foxtail barley-Weeds	5.29	1	0	0.20	----	1.96	----
13 Rushes	5.26	8	6	1.60	1.20	15.82	8.89
15 Bassia	4.31	3	7	0.75	1.75	7.24	12.67
17 Spikerushes	2.02	2	1	1.00	0.50	10.30	3.86
20 Miscellaneous	4.22	0	1	----	0.24	----	9.75**
Totals	358.58	39	52	0.14	0.15		

* Percent Acreage-Use Values (see text on nesting cover)

** Based on 1 nest in saltgrass-spikerush, 0.8 acres, 0.19 percent of total vegetation

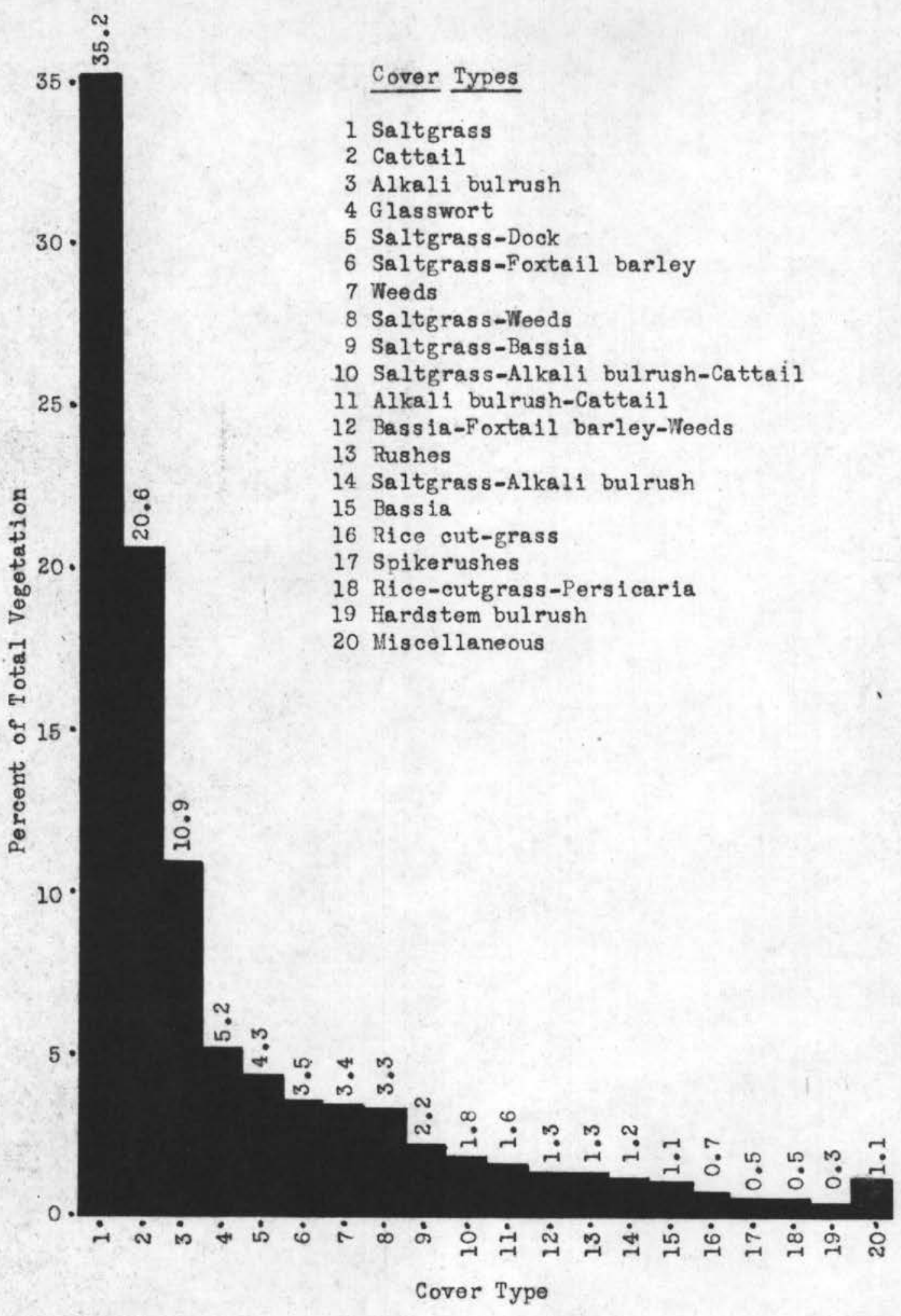


Figure 20. Comparative availability of nesting cover on the special study area at Ogden Bay Refuge - 1952

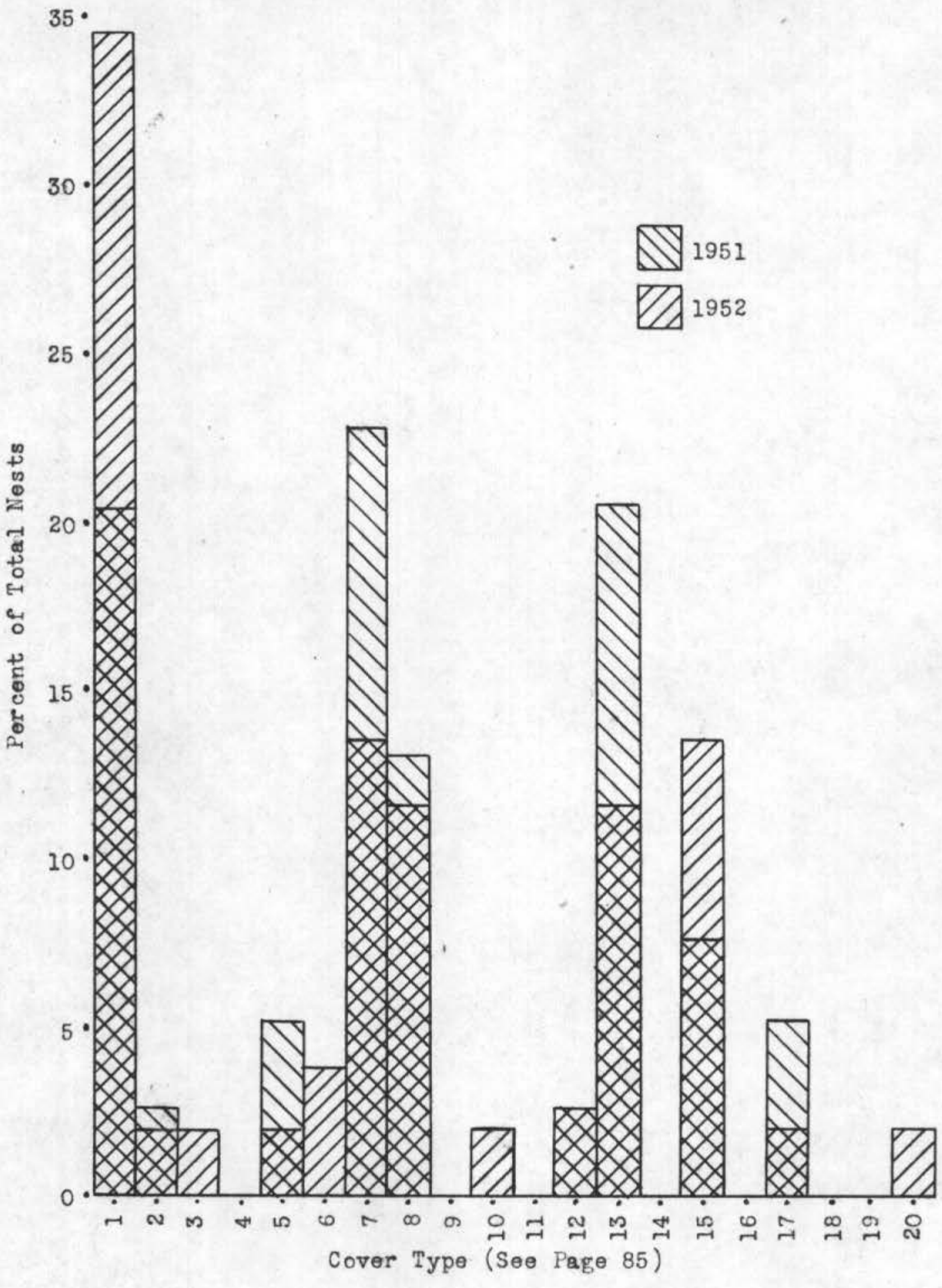


Figure 21. Pintail utilization of nesting cover on the special study area at Ogden Bay Refuge - 1951 and 1952

Figure 22. Moderately shallow, Type 2 pintail nest in a completely exposed location (see Nest materials and construction). Clutch is incomplete and very little down has been added.

Figure 23. Deep, Type 3 pintail nest under good concealment. Vegetation has been parted to reveal heavy down of an incubated clutch.

Figure 24. The best concealed pintail nest located during the study was hidden under the dome of vegetation indicated by the arrow.

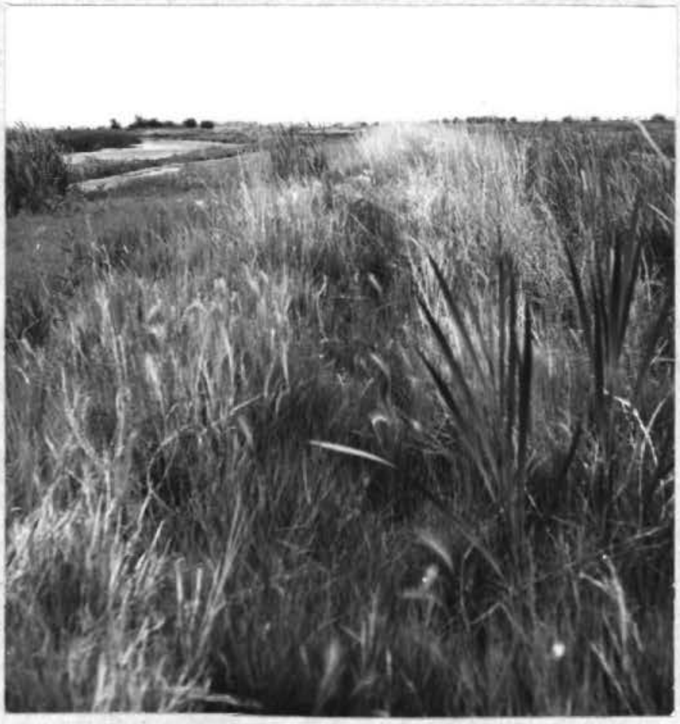


Figure 25. Dry, elevated nesting sites such as this section of dike at Ogden Bay Refuge are often selected by the early-nesting pintail. Vegetation here alternates from Hordeum jubatum and Distichlis stricta (foreground) to Bassia hyssopifolia (background).

were within 100 feet; however, considerable variation was evident in the individual classes for the 2 years. A suggested explanation for this was found in a review of water levels for the 2 seasons: some variation existed in the supply of water to the refuge in 1951 which fluctuated water levels on the nesting territories; in contrast to this, a heavy spring runoff in 1952 before nesting started forced ducks to slightly higher ground and left their nests farther from normal water lines as levels dropped later in the season.

Elsewhere on the refuge nests were found 350 yards from water, and a nest was found in a field north of the refuge at a distance of one-half mile from water at the time it hatched in 1951. Williams and Marshall (1938) found 95 percent of all nests within 45 feet of a channel at Bear River. Odin (1951) wrote that most pintail nests at Farmington Bay Refuge were "on higher ground but near water". Kortright (1943, p. 192) indicated a similar variability in nest site claiming, however, that all nests were on dry ground.

During this study only 1 pintail was known to have constructed her nest over water, a basket of saltgrass resting a scant 2 inches above shallow water on the matted stalks of alkali bulrush. Without exception, all others were built on dry ground or on a layer of vegetation over dry ground. Bent (1951) also referred to the proclivity of the pintail for dry nest sites, never having witnessed a nest in a wet situation; unlike Kortright, however, he did not rule out the possibility of a wet site being chosen.

Concealment. The degree of concealment of pintail nests was as variable as their proximity to water. The distribution of nests with respect to concealment (Table 21) showed the greatest number in the

Table 20. The relation of pintail nests to water. Special study area. Ogden Bay Refuge.

Distance (feet)	No. of Nests 1951	No. of Nests 1952	Total Nests	% of Total Nests 1951/1952	% of Total Nests Ave.*	Cumulative % 1951/1952	Cumulative % Ave.*
0-5	11	10	21	28.3/19.3	23.1	28.3/19.3	23.1
6-10	6	9	15	15.4/17.3	16.5	43.7/36.6	39.6
11-15	3	2	5	7.7/3.8	5.5	51.4/40.4	45.1
16-20	4	3	7	10.2/5.8	7.7	61.6/46.2	52.8
21-25	2	2	4	5.1/3.8	4.4	66.7/50.0	57.2
26-50	6	11	17	15.4/21.2	18.6	82.1/71.2	75.8
51-75	2	2	4	5.1/3.8	4.4	87.2/75.0	80.2
76-100	1	11	12	2.6/21.2	13.2	89.8/96.2	93.4
101-150	4	0	4	10.2/0.0	4.4	100.0/96.2	97.8
151-200	0	0	0	0.0/0.0	0.0	100.0/96.2	97.8
201-250	0	1	1	0.0/1.9	1.1	100.0/98.1	98.9
251-300	0	1	1	0.0/1.9	1.1	100.0/100.0	100.0
Totals	39	52	91	100.0	100.0	100.0	100.0

* Weighted average for both years

Table 21. Degree of concealment of pintail nests. Special study area.

Concealment	Number of Nests 1951	Number of Nests 1952	Total Nests	Percent of Total Nests	Cumulative Percent	
Excellent	0	3	3	3.3	3.3	100.0
Good	10	13	23	25.3	28.6	96.7
Fair	17	20	37	40.7	69.3	71.4
Poor	12	16	28	30.7	100.0	30.7
Totals	39	52	91	100.0		

Table 22. Number of pintail nests classified by amount of down and degree of concealment. Special study area. Ogden Bay Refuge.

	Degree of Concealment	Amount of Down				Totals
		Heavy	Medium	Light	Absent	
	Excellent	-	-	-	-	0
	Good	6	3	1	1	11
1951	Fair	7	5	1	1	14
	Poor	6	5	1	2	14
	Totals	19	13	3	4	39
	Excellent	1	1	1	-	3
	Good	6	4	2	1	13
1952	Fair	10	4	4	2	20
	Poor	7	4	3	2	16
	Totals	24	13	10	5	52
	Excellent	1	1	1	-	3
	Good	12	7	3	2	24
Total	Fair	17	9	5	3	34
	Poor	13	9	4	4	30
	Totals	43	26	13	9	91

Figure 26. Interspersion of cover types creates "edge" and enhances the value of nesting areas. A small patch of weeds (primarily Asclepias speciosa) in center of photo is bordered by Juncus balticus, foreground, and Carex nebraskensis, background.

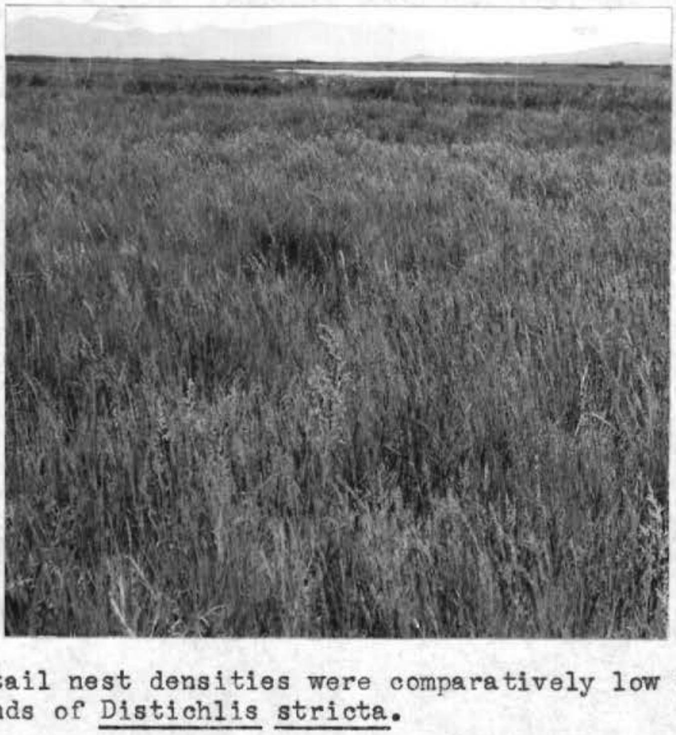


Figure 27. Pintail nest densities were comparatively low in extensive stands of Distichlis stricta.

"fair" category followed closely in both years by a large number of poorly concealed nests, the 2 categories collectively holding 71.4 percent of the 91 nests. The fact that the figures differed by a constant number in each class in spite of different yearly totals indicated a close agreement of the data for the 2 years. Excellent concealment of nests was rare; the outstanding example was the first nest to be found in 1952 (April 14), completely obscured from all sides and from above in a dome-shaped clump of the previous year's saltgrass, with only a faint pathway leading inside to indicate its presence.

Nest materials and construction

Three general types of nest construction were recognized and may be described as follows:

Type 1 - a moderately shallow depression (rarely exceeding two inches in depth) formed by the female in the earth or in a layer of dead vegetation; this nest type was typical on sparsely vegetated sites or under coarse vegetation such as weeds and bassia, where there was likely to be a thick ground mat of dried plant debris; down was the only material added to such nests and was generally present in greater quantities than in Types 2 and 3;

Type 2 - a nest built on the top of a layer of vegetation or upon the ground and constructed of dead vegetation from the immediate vicinity; this type was commonly found in rushes, spikerushes, and sedges where winter winds and snow had created mats of the previous year's growth;

Type 3 - a nest combining a depression in the ground, or plant debris on the ground, and the addition of material to this depression; such nests were always the deepest as a result of being built up as well as down, and were characteristically found in saltgrass or mixed cover types which included saltgrass.

The single nest built over water which was found during the study and described in the previous section was the only exception to the above 3 types for the study area. The plants making up the cover type in which the nest was to be located were usually utilized when Type 2 or Type 3 nests were constructed; the slender, wiry culms of saltgrass and foxtail barley appeared to be preferred.

The average of 50 measurements described the nest as having an outer rim diameter of 22 centimeters, an inner rim diameter of 16 centimeters and a depth of 8 centimeters; respective measurements showed the following ranges; outer rim diameter, 19-26 centimeters; inner rim diameter, 13-19 centimeters; depth, 6-10 centimeters.

The actual process of nest construction, although not witnessed during this study, was certainly protracted in the sense that material might be added quite consistently well into the egg-laying period. Although some pintails were known by the writer to add materials to the nest in the incubation period, such was not a general practice among these birds. Certainly it was not a characteristic beneficially employed to keep eggs above rising water levels as discussed by Hochbaum (1944) for the canvasback and by Low (1945) for the redhead. During this study only 1 pintail was known to have prevented flooding of its nest by adding material to keep the eggs above water, while a number were lost to flooding which could have been saved in this manner.

Some females began to pull down from their breast while still laying; others took off their brood with no down ever having been observed in the nest. The association of down-pulling with incubation was most frequently observed, however. Bent (1951) quotes the observations of F. Seymour Hersey on pintails nesting in Alaska where the eggs were covered with down before the set was complete.

The amount of down in pintail nests was classified by the degree of concealment of those nests (Table 22). It appeared during the study that nests under poor concealment contained a greater amount of down than did well-concealed nests. Consequently, the hypothesis that amount

Figure 28. Typical pintail territory and loafing area at Ogden Bay Refuge

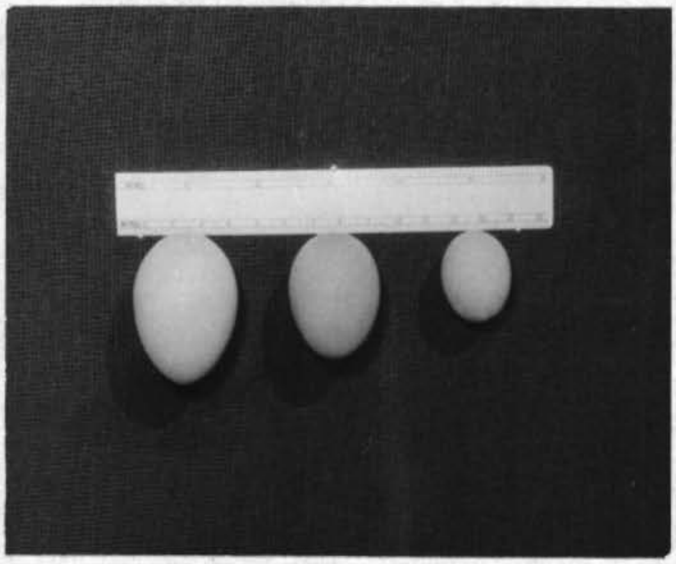


Figure 29. Variation in the size of pintail eggs. Egg on extreme left was considered normal in size, other two abnormally small.

of down was dependent on the degree of nest concealment was tested. Following the method of Dixon and Massey (1951) of two-way classification for independence, the Chi-square test showed that insufficient evidence existed at the 5 percent level of significance to say that down and concealment were dependent upon each other, and the above hypothesis was rejected.

Egg Laying

The pintail was 1 of the earliest breeders among Utah's waterfowl, preceded only by the Canada Goose and mallard during this study. In fact, pintails kept pace with mallards in the 1952 nesting season at Ogden Bay Refuge.

Nest history data disclosed that egg-laying began on approximately the same dates in 1951 and 1952, April 11 in the former year, April 8 in the latter. A similar agreement was noted in the last nest to be located in each year in which the first egg was laid on June 6, 1951, and on June 8, 1952. Peak nesting was determined by subtracting the incubation period of 23 days from the date of peak hatching as determined in Table 22. Nesting increased in 1951 to a peak during the week of May 9 to May 15, subsided somewhat during the remainder of May, and rose to a second though smaller peak during the week of June 2 to June 8, 3 weeks later; 1952 peaks came a week earlier, May 3 to May 9 and May 23 to May 29 and, in addition, were approximately equal in numbers.

The first eggs were laid with the beginning of nest construction at the rate of 1 egg per day. Disturbances early in the egg-laying period were extremely likely to cause desertion of that nest; 4 different females were flushed from nests containing 1 to 2 eggs with desertion resulting in each case; no nests in which 3 or more eggs had been laid were deserted as a result of flushing the hen. From this the writer inferred that pintails were very intolerant of human interference at their nest early in the laying period. Sowls (1950, p. 481) testified to the weak attachment of the female to nests in which she had not completed laying.

A single instance of random laying was noted of pintails on the Ogden Bay area during the study; this was attributed to a low probability of finding such eggs and a low incidence of the event rather than to its non-existence.

Time spent on the nest and the hours of egg-laying were not positively established. Although no eggs were known to have been laid after midday, hens were frequently flushed from nests containing incomplete clutches at odd hours of the afternoon. The only significant point in such instances appeared to be the fact that in each case the clutch lacked only 1 or 2 eggs of its subsequently observed complement. Were eggs deposited in the afternoon if the forenoon attempt at laying was interrupted, or was afternoon laying more common than generally believed? Could incubation have begun in the above instances before the clutch was complete? The writer was unable to answer such questions or to explain these observations.

The pintail clutch, on the basis of 61 successful nests, averaged 8.3 eggs (Table 32). Williams and Marshall (1938) and Cottam (1947) reported average clutches of 7.6 eggs (135 nests) and 8.3 eggs (35 nests), respectively; an average of 8 eggs per clutch was recorded by Munro (1944); Kortright (1943) notes a variation from 6 to 12 eggs per clutch with the usual number being less than 10. Individual sets at Ogden Bay varied from 3 eggs to 14 eggs; the instances of 3 eggs may have been renests or nests subjected to predation, while the one instance of 14 eggs in a nest (see Nest parasitism) was recorded as a dump nest.

Egg color was found to be extremely variable, ranging from pale olive-green to greenish-buff, grayish-buff, and pale olive-buff; except for size differences, pintail eggs might be most easily mistaken for mallard or shoveller eggs. Kortright (1943) listed the average size as 2.16 by 1.50 inches (54.9 by 38.2 millimeters). Measurements by the writer on 161 eggs revealed an average normal size of 53.6 by 37.8 millimeters with a range of 48.5 to 57.9 millimeters in length and 33.3 to 40.4 millimeters in width. Within a set, variation in egg dimensions was scarcely smaller than between eggs of different sets; the maximum variation in any set was 7.1 millimeters in length and 4.8 millimeters in width. Two eggs which were abnormal in size were found during the study (Figure 29). The smaller of the 2 measured 31.2 by 23.1 millimeters and the larger 45.0 by 32.5 millimeters. The contents of each egg appeared normal though both were infertile.

Average weight of 33 eggs which had not been incubated was 41.55 grams, with a range extending from 36.70 to 46.10 grams.

Incubation

In none of the cases observed during the study was the initiation of incubation delayed more than 24 hours beyond the time of laying the last egg. That it may begin earlier, either with the laying of the last egg or before the clutch is complete, seemed possible to the writer in view of the observed presence of females on their nests late in the afternoon before the clutch had been completed. This would explain (not to the exclusion of other explanations, however) the occasional

Table 23. Size of testes in some pintails collected at Ogden Bay Bird Refuge - 1952

Date	Age	Plumage	Testes (centimeters) Right	Left
May 3	Adult[1]	Breeding	5.1x1.9	4.9x1.9
June 7	"	Post-nuptial molt	4.2x1.3	4.1x1.3
June 7	"	" " "	4.4x1.4	4.1x1.3
June 7	"	" " "	4.2x1.4	4.0x1.1
June 14	"	" " "	4.2x1.3	4.1x1.4
June 14	"	" " "	3.4x1.1	3.5x1.0
June 21	"	" " "	3.0x1.1	2.8x0.9
June 21	"	" " "	3.5x1.2	3.3x1.2
June 21	"	" " "	2.4x0.7	1.8x0.9
June 28	"	Eclipse	2.0x0.8	2.3x0.9
June 28	"	Post-nuptial molt	2.4x0.9	2.4x0.7
June 28	"	" " "	2.2x0.8	2.3x0.6
July 8	"	Eclipse	2.0x0.7	1.9x0.8

1. Found dead but no apparent internal swelling

finding in abandoned nests of unhatched eggs containing full-term embryos, or of pipped and partially hatched eggs containing dead ducklings.

The incubation period, as determined by observation of 12 nests and artificial incubation of 4 clutches, was 22 to 23 days. In all of these cases, all eggs hatched within 8 hours of the time of the first hatch and no difference was noted between artificial incubation period and that in the wild.

As disclosed by this investigation, incubating females regularly left the nest for a period of approximately 1 hour beginning at 4:30 or 5:00 in the afternoon. At such times, they were often observed feeding or resting and preening within a relatively short distance of the nest site. A progressive decrease in weight was noted under such a schedule. In fact, the writer, handling nest-trapped females, wondered if they left their nest daily during the final stages of incubation, so light were the birds and so prominent their breastbones. It seemed quite likely that time spent away from the nest decreased as the time of hatching drew near.

With respect to attachment to the nest, Bent (1951) wrote of the female pintail, ". . . she is a very close sitter and is often nearly trodden upon before she will leave the nest". The writer did not find this as frequently true for the pintail as for mallards and cinnamon teal. The average flushing distance for 124 observations was 18 feet with extremes of 1 foot and 200 feet. In a few instances females always flushed at approximately the same distance while, in others, the distance varied considerably from time to time regardless of the stage of incubation. For the most part, however, the flushing distance decreased as incubation progressed. Twice during the study an incubating female was caught by dropping a steel frame covered with fish netting (Figure 33) over her; this was accomplished by carrying the frame in a horizontal position against 1 hip, following a straight line of walk to pass within 2 feet of the nest, and dropping the frame when it was over the female.

Hatching

As shown in Table 26 hatching began in the second week of May during both years of the study and extended through an equal period of time, terminating in the third week of July. Peak hatching, indicated at the center of the brackets which were added to each year's data, was 7 to 10 days earlier in 1952 than in 1951. Two peaks appeared evident for both years. This was believed to be the result of (1) differences in weather and water levels, which in turn influenced (2) renesting and its incidence. An innate biological variation in breeding cycles among females may also have influenced the spread of nesting and hatching.

In each case the brackets of Table 26 include an equal interval of time and a group of hatching frequencies which are noticeably higher than those immediately preceding or succeeding the enclosure; furthermore, the preceding and succeeding periods are characterized by a rather gradual increase and subsequent gradual decrease in frequencies. On the basis of the 2 years' data, it is suggested that the interval of peak hatching occurs within plus or minus one week of June 1 and is not greater than 2 weeks in duration. The time is probably influenced by weather and water levels and the duration conditioned by physiological variation in the birds. Second peaks are probably unrelated to first peaks in point of time but, otherwise, appear to exhibit the same

Table 24. Clutch size of successful pintail nests in relation to nesting cover utilized. Special study area. Ogden Bay Refuge. 1951-1952.

Clutch Size	Cover Type* 1	2	5	6	7	8	10	12	13	15	17	20
	Number of Nests											
4	0	0	0	0	0	1	0	0	0	0	0	0
5	1	0	0	0	0	0	0	0	2	0	0	0
6	0	1	0	0	0	0	0	0	1	2	0	0
7	4	0	0	0	0	1	0	1	2	1	1	0
8	3	0	1	1	3	3	0	0	1	1	1	0
9	5	0	0	0	3	2	0	0	3	2	0	1
10	3	0	0	1	0	0	1	0	0	1	0	0
11	1	0	0	0	0	0	0	0	0	0	0	0
12	1	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	1	0	0	0
14	0	0	0	0	0	0	0	0	1	0	0	0
Total	18	1	1	2	6	7	1	1	11	7	2	1
Ave. Clutch	8.6	6.0	8.0	9.0	8.5	7.6	10.0	7.0	8.4	7.8	7.5	9.0

Table 25. Hatching success of pintail clutches in relation to nesting cover utilized. Special study area. Ogden Bay Refuge. 1951-1952.

Size of Hatch	Cover Type* 1	2	5	6	7	8	10	12	13	15	17	20
	Number of Nests											
1	1	0	0	0	0	0	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	1	0	0	0
3	0	1	0	0	0	0	0	0	0	2	0	0
4	1	0	0	0	1	1	0	1	1	2	0	0
5	3	0	0	0	1	1	0	0	1	0	1	0
6	0	0	0	1	0	0	0	0	1	0	0	1
7	4	0	0	0	0	3	0	0	1	0	0	0
8	1	0	1	0	3	1	1	0	2	1	1	0
9	3	0	0	1	1	1	0	0	2	2	0	0
10	2	0	0	0	0	0	0	0	0	0	0	0
11	1	0	0	0	0	0	0	0	0	0	0	0
12	1	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	2	0	0	0
Total	18	1	1	2	6	7	1	1	11	7	2	1
Ave. Hatch	7.1	3.0	8.0	7.5	7.0	6.7	8.0	4.0	7.6	5.7	6.5	6.0

* See Cover Type Key, Table 18.

Table 26. Number of hatched pintail nests by weekly periods and daily intervals from date of first known hatch. Special study area. Ogden Bay Refuge.

Weekly Period	No. Hatched 1951	No. Hatched 1952	Weekly Period	No. Hatched 1951	No. Hatched 1952
May 10 - May 16	0	3	June 14 - June 20	2	7
11 - 17	0	2	15 - 21	2	10
12 - 18	2	2	16 - 22	2	9
13 - 19	1	2	17 - 23	3	8
14 - 20	1	2	18 - 24	4	9
15 - 21	1	3	19 - 25	5	8
16 - 22	1	4	20 - 26	4	8
17 - 23	1	4	21 - 27	3	6
18 - 24	2	4	22 - 28	3	5
19 - 25	2	6	23 - 29	3	5
20 - 26	2	8	24 - 30	6	6
21 - 27	1	8	25 - July 1	6	4
22 - 28	2	8	26 - 2	5	3
23 - 29	2	8	27 - 3	5	3
24 - 30	4	8	28 - 4	5	3
25 - 31	3	8	29 - 5	6	2
26 - June 1	9	10	30 - 6	7	4
27 - 2	11	8	July 1 - 7	3	3
28 - 3	12	8	2 - 8	2	3
29 - 4	13	7	3 - 9	2	4
30 - 5	16	6	4 - 10	3	4
31 - 6	16	6	5 - 11	3	4
June 1 - 7	17	5	6 - 12	2	3
2 - 8	12	0	7 - 13	1	1
3 - 9	11	0	8 - 14	1	1
4 - 10	10	1	9 - 15	2	1
5 - 11	7	4	10 - 16	2	0
6 - 12	5	5	11 - 17	2	0
7 - 13	4	5	12 - 18	2	1
8 - 14	3	5	13 - 19	2	1
9 - 15	2	6	14 - 20	2	1
10 - 16	2	7	15 - 21	2	2
11 - 17	1	7	16 - 22	1	1
12 - 18	1	6	17 - 23	1	1
13 - 19	2	5	18 - 24	0	1

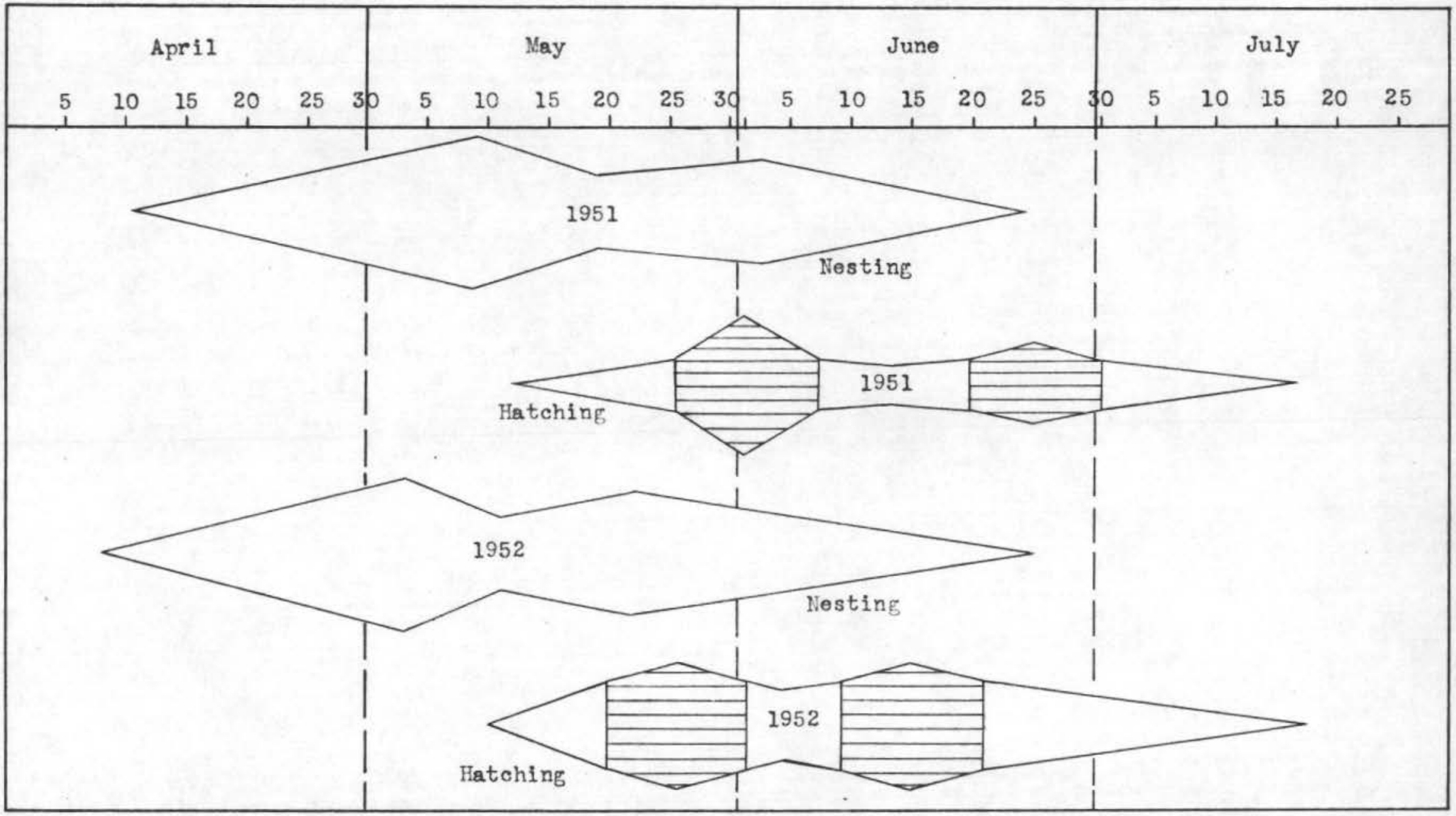


Figure 30. Span of pintail nesting and hatching. Special study area. Ogden Bay Refuge. Cross-hatching indicates interval in which true peak may have been attained.

characteristics.

Kalmbach (1939) presented a summary of nest and egg data in which the average hatch for more than 7,600 duck and goose nests studied in both the United States and Canada was 60 percent. It was Kalmbach's opinion that 70 percent nest success should be the management objective and that the remaining loss was probably inevitable. Bizeau (1951) found a nest success of 67 percent and an egg success of 62 percent for pintails at Gray's Lake, Idaho, in 1949 and 1950. Spencer (1953, p. 120) recorded an egg success of 58 percent for 99 pintail eggs at Ogden Bay in 1950. These data provided a basis for the comparison of the data from the writer's study.

Table 30 shows a 2-year nest and egg success of 71 percent and 63 percent, respectively. While the corresponding figures for the individual years show some variation from this average, none of them are under the 60 percent average tabulated by Kalmbach.

Average overall fertility for pintail eggs under observation was 95 percent (Table 31). The 5 percent loss from infertility may have been due in part to late nesting or renesting. By the first of June, many males were entering the post-nuptial molt. From the fact that a degeneration of the testes accompanied this molt (Table 23), it was inferred that such birds had passed the peak of physiological breeding condition. Following this line of reasoning, it seemed likely that some infertility resulted from failure of the males to pair off when in the post-nuptial molt, cessation of spermatogenesis, or lack of viable spermatozoa. At no time up to the first of July would a female be unable to find a male on this area.

Fertility of deserted eggs averaged 39 percent for the 2 years of the study. The possibility of this figure being high and its significance with respect to production were mentioned in the previous section. Average hatch for 61 successful nests was 7.0 eggs per nest.

Table 25 reveals that the largest hatches (13 eggs) occurred in rushes, but that the greatest number of successful nests (18) were located in saltgrass. When successful nests were expressed as a percent of the total nests in each cover type, 3 types showed 100 percent success (Table 29). Eliminating all the small samples (less than 7 nests), greatest success was noted in rushes. This was followed by bassia, saltgrass, saltgrass-weeds, and weeds, in that order. This procedure associated the cover type showing the least success with the 1 showing the highest predation in Table 28.

The actual hatching of pintail eggs probably differs little from that of other dabbling duck eggs. Pipping for this species, which has an incubation period of 22 to 23 days, occurs on the twenty-first to the twenty-third day of incubation. Movement and peeping can be felt and heard within some eggs at least 1 full day in advance of the pipping. Several punctures in the shell around the periphery of the "cap" are effected by the egg tooth and movement of the duckling. Within a maximum of about 30 hours of the first puncture, the cap is completely distinguishable from the remainder of the shell by an encircling fracture. The duckling generally emerges within one-half hour of the cap being so loosened. Actual emergence requires a great deal of energy for so small a creature; by vigorous struggling, the body is moved toward the opening until the feet and posterior end roll free, after which the head and neck are straightened and withdrawn from the shell. A small semi-liquid mass of excretory matter remains in the shell membrane, drying completely within about 3 hours.

In all incubator hatches the cap remained attached to the rest of the shell by a fragment of membrane; in natural hatches, however, trampling by the adult female and ducklings usually pulverized the empty shells, leaving only the flattened, somewhat leathery shell membrane intact. These membranes were counted to verify the number of eggs which had hatched.

In all observed hatches in the field, the minimum known interval between the first and the last egg to hatch was 4 hours; in incubator hatches the maximum was approximately 1 full day.

Ducklings remained in the nest at least until the down was dry. In none of the observed cases did they linger there more than 1 full day.

Nest parasitism

Bent (1951) stated that it was unusual to find the eggs of other ducks in pintail nests. Although this statement may apply to other pintail breeding grounds it was not found true of the special study area. Six pintail nests were parasitized by other ducks in each year of the study, and 1 pheasant egg was found in each of 2 pintail nests in 1952. Duck parasitism, therefore, was sustained in 15.4 percent of the pintail nests located in 1951, and in 13.2 percent of the 1952 nests. Total parasitism was 15.4 percent in each year. The greatest number of eggs left in any 1 pintail nest was the 7 mallard eggs observed in 1951; this nest also contained 9 pintail eggs, all of which were incubated by the female for about 6 days after which the nest was abandoned. One egg was missing. Although predation may have precipitated desertion, a weak attachment to the nest was indicated. The remaining eggs listed as deserted in Table 27 were left in successful

Figure 31. Number 2 nest predator on the study area at Ogden Bay Refuge. Several nests within a radius of one-half mile of the den of this adult male skunk had sustained skunk predation.

Figure 32. Excellent nesting and brood-rearing areas are contingent upon each other in the well-interspersed marsh at Ogden Bay Refuge. A 2-3 inch rise in water levels is often sufficient to flood a number of nests in such level terrain, however.

Table 27. Incidence of mallard, redhead and pheasant eggs in pintail nests on the special study area at Ogden Bay Refuge

	Nest Parasite	Pintail Nests Parasitized	Eggs Deposited	Fate of Eggs Deposited		
				Hatched	Destroyed	Deserted
1951	Mallard	1	7	0	7	0
	Redhead	5	6	0	4	2
	Pheasant	0	0	0	0	0
1952	Mallard	0	0	0	0	0
	Redhead	6	15	7*	4	4
	Pheasant	2	2	1	1	0

* Three of these were hatched in an incubator

nests. Consequently, it was concluded that the number of parasite eggs in a pintail's nest was usually too small to be a matter of serious concern to pintail production, although the incidence of such nest parasitism be moderately high.

The incidence of intraspecies nest parasitism, or "dump" nesting, was apparently very low, being represented during this study by a single known case. Classifying the nest as a "dump" nest was based entirely on clutch size and a marked difference in egg color, 6 eggs being a pale olive-green while 8 were an olive-buff. Whether or nor this also represented some form of social enterprise with more than one hen participating in the incubation could not be stated. Only 1 female was observed at a time on or near the nest but the writer was unable to verify her identity by natural markings or by capturing and giving her an artificial marking. Thirteen eggs of this clutch were hatched successfully and the fourteenth proved to be infertile upon examination.

Although the incidence of "dump" nests may be higher than anticipated by virtue of the inability to distinguish a less pronounced differentiation in egg color, pintails can successfully incubate a clutch of 14 eggs. A nest containing this number of pintail eggs is a rare thing in itself. Therefore, "dump" nesting is not deemed a factor in lowering nesting success among pintails.

Nest destruction and desertion

Destruction: predation, flooding, unknown. California Gulls (Larus californicus), which nested in large colonies on the west side of Ogden Bay Refuge, were the most abundant predator on the area during the nesting season. The potential ability of these birds to lower waterfowl production was emphasized by Odin (1951). Second in abundance on the study area, and a known predator, was the Large Striped Skunk (Mephitis mephitis). Williams and Marshall (1938) blamed the magpie (Pica pica hudsonia) for nearly all nest depredation at Bear River Refuge. Magpies were commonly seen on the study area, nesting in willows which border its east side, but were rarely seen out on the marsh and never noted at a duck's nest. It is possible that they accounted for some of the nest losses attributed to gulls or unknown causes.

Other potential nest predators in the area included the weasel (Mustela cicognani), raven (Corvus corax), duck hawk (Falco peregrinus), prairie falcon (Falco mexicanus), the horned owl (Bubo virginianus), bald eagle (Haliaectus leucocephalis), golden eagle (Aquila chrysaetos canadensis), the Great Basin gopher snake (Pituophis catenifer deserticola), and domestic or feral cats and dogs.

During the 2 years of the study, an average of 33 percent of all pintail nests located failed as a result of flooding, predation or activities of the investigator (Table 32). Within the classification of unsuccessful nests, unknown causes and gull predation were approximately equal as the greatest cause of nest failure with the remaining 3 factors also approximately equal and not exceeding 50 percent of the primary causes. The 5 nest losses attributed to the investigator came about as a result of flushing females from nests early in the egg-laying period, but represented a loss of only 6 eggs as compared to 17 by skunks and 18 by flooding.

A total of 11 of the 91 nests located during the study sustained gull predation for an average of 12 percent. At Farmington Bay Odin (1951) reported gull predation on 26.8 percent of 41 pintail nests located. Unknown causes of destruction were twice this amount

(26 percent) but undoubtedly consisted largely of gull depredation also. In spite of an abundance of gulls and a complete lack of observed predation by anything but gulls and skunks, nest loss was attributed to unknown causes if any doubt attended the agent of destruction.

Most of the predation recorded for successful nests consisted of the complete disappearance of eggs. When this occurred with no disturbance to the nest the female returned to incubate. Demolishing the nest or leaving broken eggs in it generally resulted in desertion.

In terms of number of eggs lost, nest destruction reduced potential production from 677 eggs laid in observed nests by an average of 31.6 percent (214 eggs). The order of importance of the different agents remains unchanged - unknown, gulls, skunks, flooding, human interference.

In view of a skunk control program on the refuge during the winter of 1951-52, it was anticipated that skunk predation might be reduced during the 1952 season. Such was not the case. The influx of skunks from surrounding farmland during the spring was undoubtedly sufficient to counteract the effects of a control program on the refuge. An unusual instance of this was witnessed during the heavy spring runoff of 1952 when a skunk gained access to the refuge after floating down the river on a log.

Flooding claimed 10.6 percent of the eggs in unsuccessful nests during the study but only a small proportion of all eggs laid (2.7 percent). Fluctuating water levels in 1951 destroyed 3 nests. In 1952, high water levels, which later receded, forced early nesters to higher ground; consequently, no pintail nests were lost to flooding on the study area. Uncontrolled water levels on much of the surrounding farm land, which pintails utilized for nesting, undoubtedly destroyed many nests.

Relating depredation to the cover type utilized for nesting (Table 28) showed that the greatest loss of nests occurred in weeds under fair to poor concealment. Near-equality of nesting losses under fair and poor concealment was due in some measure to border-line cases where concealment could have been classed as either. Lumping the excellent and good classes in a single category, and then doing the same for the fair and poor, overcame this obstacle with no loss of data. This associated 21 percent of the losses (8 nests) with the better concealment as compared to 79 percent (31 nests) with the poorer type of concealment. A test of the hypothesis that nest losses were independent of the degree of concealment revealed a Chi-square value of 13.78. The tabular value of Chi-square (Dixon and Massey, 1951) for 1 degree of freedom at the 0.5 percent level of significance was 7.88. This was a highly significant difference. It was, therefore, concluded that nest losses were related to nest concealment.

Odin (1951), under a slightly different classification of concealment, found that gulls destroyed 7.7 percent of all pintail nests under good concealment, 26.7 percent of those under fair concealment, and 46.2 percent of the poorly concealed nests.

Referring to the limits of the individual categories (page 71) it seems likely that vegetation offering some concealment from above is an important factor in reducing predation upon nests. The difficulty of assessing concealment in the eyes of a predator is recognized. Nevertheless, the methods of camouflage teach that whatever breaks up a solid pattern of color, or a solid shadow, aids concealment. Any vegetation above the nest would tend to do this very thing.

Table 28. Frequency of predation in relation to nesting cover and degree of concealment. Special study area. Ogden Bay Refuge. 1951 and 1952.

Concealment	Cover type*								Total
	1	2	3	7	8	12	13	15	
Excellent									0
Good				3	1		2	2	8
Fair	3		1	6			2	3	15
Poor	3	1		2	5	1	2	2	16
Total	6	1	1	11	6	1	6	7	39

* See Table 18

Table 29. Pintail nest success in relation to cover type. Special study area. 1951 and 1952.

	Cover type*											
	1	2	5	6	7	8	10	12	13	15	17	20
Total nests	26	2	3	2	16	11	1	1	14	10	3	1
Successful nests	18	1	1	2	7	7	1	1	12	8	2	1
Percent successful	69.2	50.0	33.3	100.0	43.8	63.7	100.0	100.0	85.8	80.0	66.7	100.0

* See Table 18

Table 30. Summary of nest and egg success for pintail nests under observation. Special study area. Ogden Bay Refuge.

Year	NESTS			EGGS		
	Total Nests Terminated	Total Nests Successful	Percentage Nest Success	Total Eggs Terminated*	Total Eggs Hatched	Percentage Egg Success
1951	38	25	65.8	289	178	61.0
1952	48	36	75.0	382	248	64.9
Total	86	61	70.9	671	426	63.5

* Eliminates nests and eggs deserted due to human interference; averaged less than 2 eggs per nest (5 nests, 6 eggs).

Table 31. Fertility of pintail eggs on the basis of successful nests. Special study area.

Year	Total Eggs in Successful Nests	Live Hatch	Deserted			Missing	Fertility of All Eggs (percent)	Fertility of Deserted Eggs (percent)
			Dead Embryo	Dead Hatch	Infertile			
1951	205	178	8	0	6	13	96.8	57.1
1952	302	244	4	4	19	31	93.0	29.6
Total	507	422	12	4	25	44	94.6	39.0

Table 32. Pintail nesting data from the special study area. Ogden Bay Refuge. 1951 and 1952.

	1951	1952	Total
Total nests located	39	52	91
Successful, preyed upon	25(64.1)*	36(69.2)	61(67.0)
Skunk predation	0	1(2.8)	1(1.6)
Gull predation	0	1(2.8)	1(1.6)
Unknown agents	6(24.0)	9(25.0)	15(16.5)
Unsuccessful	14(35.9)	16(30.8)	30(33.0)
Flooded	3(21.4)	0	3(10.0)
Skunk	1(7.1)	2(12.5)	3(10.0)
Gull	4(28.6)	6(37.5)	10(33.3)
Unknown agents	5(35.8)	4(25.0)	9(30.0)
Human interference	1(7.1)	4(25.0)	5(16.7)
Total eggs laid	290	387	677
Eggs in successful nests	205(70.7)	302(78.0)	507(74.9)
Hatched	178(86.8)	248(82.1)	426(84.0)
Deserted	14(6.8)	23(7.6)	37(7.3)
Destroyed	13(6.4)	31(10.3)	44(8.7)
Skunk	0	2(6.4)	2(4.6)
Gull	4(33.7)	6(19.4)	10(22.7)
Unknown agents	9(66.3)	23(74.2)	32(72.7)
Eggs in unsuccessful nests	85(29.3)	85(22.0)	170(25.1)
Flooded	18(21.2)	0	18(10.6)
Skunk	8(9.4)	9(10.6)	17(10.0)
Gull	22(25.9)	49(57.6)	71(41.8)
Unknown agents	36(42.3)	22(25.9)	58(34.1)
Human interference	1(1.2)	5(5.9)	6(3.5)
Average clutch size (successful nests)	8.2 eggs	8.4 eggs	8.3 eggs
Average hatch (successful nests)	7.1 eggs	6.9 eggs	7.0 eggs

* Figures in parentheses are percentages of the total for subgroups

Table 33. Comparative nesting data for 7 species of waterfowl on the special study area. Ogden Bay Refuge. 1951 and 1952.

Species	Nests Located No.	Nests Located %	Nests* Terminated	Nests Successful	Ave.** Nest Success	Eggs Laid	Eggs* Terminated	Eggs Hatched	Ave.** Egg Success	Ave.** Clutch	Ave.** Hatch
Teal, Cinn/B-W	144	24.3	139	88	63.3	1310	1303	763	50.9	10.1	8.7
Gadwall	130	21.9	127	94	74.0	1299	1296	833	64.3	10.4	8.9
Mallard	114	19.2	111	83	74.8	974	968	688	71.1	9.6	8.3
Pintail	91	15.4	86	61	70.9	677	671	426	63.5	8.3	7.0
Redhead	49	8.3	49	34	69.4	520	520	230	44.2	11.1	6.8
Shoveller	42	7.1	42	25	59.5	394	394	201	51.0	10.3	8.0
Canada Goose	22	3.8	22	22	100.0	119	119	103	86.5	5.4	4.7
Totals	592	100.0	576	407	70.6	5293	5271	3244	61.5	9.7	8.0

* Eliminates nest losses early in nesting period caused by human interference; such nests contained an average of less than 2 eggs.

** Weighted averages for the 2 years of the study

No predation on laying or incubating females was noted.

<u>Desertion</u>. While the term "desertion" may be applied in a general way to the abandonment of a nest, it seems incorrect to say that a nest failed because of desertion. Predation, flooding, harassment, human interference - these are the causes of nest failure to which desertion bears the relation of effect. In the analysis of nesting data in this work, desertion refers to eggs remaining in successfully terminated nests; in this sense it can be placed on a par with destructive agents as a factor in lowered production.

Of the total number of eggs laid in both years of the study (677), only 37 or 5.5 percent were deserted. This loss was slightly less than the combined effect of gull, skunk, and unknown predation on eggs in nests which subsequently terminated, a loss of 6.5 percent (44 eggs). In terms of successfully terminated nests (to which desertion applies), the loss from desertion amounted to 7.3 percent, while gull predation alone claimed 1.9 percent of the eggs. Nevertheless, gull predation was more serious to production than was desertion. The key to the significance of this statement was in the fertility of deserted eggs as compared to that of all eggs laid (Table 31). Approximately 95 eggs of every 100 taken from nests by gulls were potential ducklings; in contrast to this, only 39 eggs of every 100 deserted were potential birds-in-the-marsh.

The calculated fertility of deserted eggs may have represented a maximum since it included partially hatched ducklings which were occasionally found dead in a nest. Such occurrences were not common and may have been normal deaths resulting from suffocation, trampling, or disease; however, in spite of efforts to keep disturbance at a minimum, the daily presence of someone on the marsh was sufficient at times to cause a female to take her brood from a nest when she might otherwise have stayed long enough to effect the successful hatch of another duckling. Therefore, partially hatched dead ducklings, as a result of interference, would have increased the tabulation of deserted fertile eggs.

The following notation from a 1951 nest history form is considered indicative of a disturbance at hatching:

> 6/18/51. Six eggs pipped, 7th missing. Female remained within 50 feet feigning injury and very excited until I left.
>
> 6/20/51. No sign of female. One membrane in nest, 2 partially-hatched dead ducklings, and 3 eggs still hatching. Removed 3 live eggs to incubator.

Discussion: comparative importance of nesting pintails

Although not a major breeding ground for pintails, the Salt Lake Valley supports sizeable breeding populations of this species. Nesting densities, while probably never attaining the maximum possible in this area, definitely vary in different cover types and probably also with the size of the breeding population on a given area. Utilization of cover types changes from year to year depending on water levels, and growth of the vegetation as induced by weather early in the season.

In general, the nesting season begins earlier than for any other ducks in this area except the mallards and occurs at the same time each year. Minor differences in initiation, peaks, and termination are conditioned by local weather and the spring runoff in the streams supplying the marshes with water. Controlled water levels on the managed areas stabilize this period and increase nesting success as compared to adjoining unmanaged areas with no control over flooding.

Loss of eggs to predators is the greatest cause of reduced pintail production at Ogden Bay Refuge and Farmington Bay Refuge with the California Gull leading the list of known offenders. This appears related to a proclivity of the pintail for drier, more exposed nesting sites associated with a large population of gulls. Since California Gulls are protected by the state, a challenge to management exists.

Nearly half a century ago the pintail was listed as the seventh most abundant nester on the Bear River marshes (Cottam, 1947). By 1937, Williams and his co-workers (Williams and Marshall, 1938) ranked the pintail fifth in importance as a nesting species on the basis of 2,410 observed waterfowl nests; preceding it in importance were gadwalls, cinnamon teal, redheads, and mallards in that order, with gadwalls topping the list. The work of Spencer (1953, p. 111) showed the pintail in fourth place on his study area at Ogden Bay.

The 2-year study at Ogden Bay, with a sample only one-quarter as large, indicates some rearrangement of the above order of importance (Table 33). It is suggested, however, that any differences may be more apparent than real, and, in particular, that there is a danger in generalizations from nesting studies on a specific area over a short period of time. An example of this is at hand. In the opinion of the writer the nesting survey at Ogden Bay was representative of the relative size of breeding populations on the study area; Table 4 indicates, however, that the same status among the species is not necessarily true for the entire refuge or other areas inasmuch as redheads and cinnamon teal consistently vie for first place in the counts of breeding pairs. Observations throughout both nesting seasons substantiate the feeling that redheads, on the refuge as a whole, deserve a higher rating than the sixth place given to them on the study area.

Of particular interest to this study is the fact that the pintail retained fourth place in importance in each year of the study. Perhaps even more important in relative standing is the need to consider nest and egg success or average hatch along with the breeding population for a species. For example, the breeding population of teal must produce 12 percent more eggs than the pintail to hatch as many ducklings; redheads must produce 20 percent more eggs to keep their hatch on a par with the pintail. For equal numbers of adults, then, management for pintail production would appear to yield better results than management for redheads or any other species showing a markedly lower nest and egg success. Worded a little differently, management of an area similar to the study area to increase redhead production from a given breeding population might well mean a less economical program, since action to increase nest and egg success would be required.

It is worthy of note that average nest success for all species on the study area was just over the 70 percent which Kalmbach (1939) believed to be the management objective; egg success, while considerably lower, was still above the 60 percent average which he found to exist on a number of United States and Canadian refuges. The pintail was slightly above the average for all species in both nest and egg success.

In the final analysis, this discussion is probably applicable to small areas and local problems; it is just such considerations, however, which appear to be increasing in their importance to the overall picture and future of waterfowl.

RENESTING

Various workers have investigated the details of renesting in waterfowl to evaluate the effects of nest losses on production. Kalmbach (1938) classified nests according to "early" or "late season" while Bennett (1938) and Low (1945) distinguished renests by amount of down, clutch size, and lateness of the season.

A study by Sowls (1949) covered renesting in 7 species of ducks and was the only work of its kind to which this writer had reference with respect to pintail renesting. For the pintail, Sowls was unable to distinguish renests from first nests by clutch size. Although each renest under observation showed a noticeable decrease in the amount of down as compared to the first nest, a great deal of variation was noted in the amount of down in the renests of different hens. Therefore, clutch size and amount of down were of no value as criteria of renesting under natural conditions.

The purpose of attempting a renesting study at Ogden Bay Refuge was to establish the fact that renesting did occur and, if possible, to obtain data on its incidence as well as the interval between nesting attempts.

During the 1951 nesting survey 4 observations led to the renesting study which was conducted in 1952: (1) very little courtship activity of any kind was noted early in the season, (2) nest losses were noted soon after nesting began, (3) courtship activity began to be observed more frequently by the first of May, and (4) hatching dates indicated

Figure 33. Nest trap set over a pintail nest. Cord is attached to tripping stick which holds steel frame upright.

Figure 34. The nest trap sprung over an incubating pintail on the special study area at Ogden Bay Refuge

Figure 35. A nest-trapped female being wing-painted prior to release. Painted wing was visible at distance of one-quarter mile when bird was flying.

Figure 36. Outer primaries of the right wing of this hen pintail have received 2 coats of dope, those of the left wing only one coat.

a second peak in nesting (Table 26).

Techniques

Coincident with the regular 1952 nesting study, females were trapped on the nest and given an identifying mark. The nest trap used (Figure 33) was identical to the one described by Sowls (1949) and was operated in a similar manner. Best results were obtained on windy days when the approach of the investigator was less audible to the hen. Testor's airplane dope in red, yellow, white, and green was used to paint the 5 outer primaries of 1 or both wings, with no more than 1 color being used on a wing. Four colors and 2 wings allowed 36 distinct combinations and single colors. Two coats of dope were applied, the wing being held in an extended position to dry before the second coat was applied. All colors were visible on the flying bird at a distance of 500 feet under any daylight conditions; with 7x35 binoculars this distance was increased to one-quarter of a mile.

Twenty-five females were trapped and marked in this manner and banded with Fish and Wildlife Service aluminum bands. The nests of 10 birds trapped outside of the special study area were robbed of their eggs to simulate destruction and precipitate the renesting attempt. Eggs from such nests were taken to an incubator for hatching. None of the 15 females trapped on the special study area was robbed of their eggs since it was desirable to get as natural a picture of nesting on that area as was possible. Painting these 15 females was expected to yield the same results in the event of natural destruction as the painting of those off the study area; in addition, the marked females might facilitate subsequent brood counts.

Results and conclusions

In one instance, a female was back on the nest within 5 hours of the time that she was trapped and marked. Only twice, however, was a female caught on the day that the trap was set and in each case a strong wind was blowing. The females at first appeared suspicious of the trap and very alert while incubating under it. Generally, attempts to catch them sooner than 1 day after setting up the trap failed with the female escaping under the edge of the trap before it grounded. Attempts on the third day were universally successful.

No damage to hens resulted from the trapping and only 2 eggs were broken in the 25 nests. Both of these eggs were cracked by the actions of the female in trying to escape. In most instances, the female was sufficiently restricted by the trap netting to minimize her movements.

Vegetation around the nest was frequently broken down in a conspicuous manner as a result of the trapping and activity at the nest. Nevertheless, only 1 nest (4 percent) was destroyed and this by gulls; no nests were deserted due to trapping. Since gull predation on the study area for the 2 years 1951 and 1952 accounted for a much larger percent of the nests (12 percent) there was no reason to assume that nest trapping was detrimental to the species or to production.

The female whose nest was destroyed by gulls was sighted 4 days later, May 21, and again on May 22. On both occasions she was attended in flight and on the ground by 2 drakes. On May 21, courtship flight was witnessed for fully 5 minutes. This was the same type of activity noted in 1951, and again in 1952. No renest was ever located for this female nor was she ever sighted again.

This portion of the study was concluded with only 1 renest having

Figure 37. Typical pintail brood cover along a ditch at Ogden Bay Refuge. Duckweed (Lemna minor) can be seen on the water and insect life is abundant in the emergent vegetation.

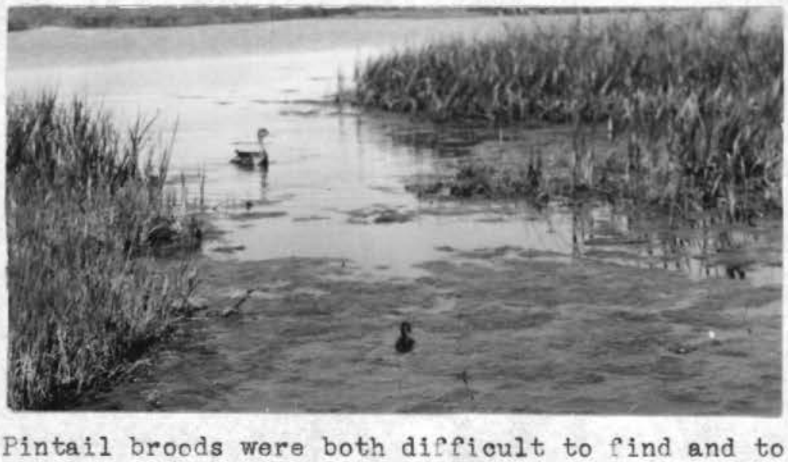


Figure 38. Pintail broods were both difficult to find and to count at Ogden Bay Refuge. Here a single duckling from a brood of undetermined size, encountered in vegetation at left, revealed itself.

been found. Nest P-20 contained 9 eggs when the female was trapped, and incubation had progressed to the tenth day. The hen was marked and released at 11:30 in the morning with no drake observed in the area; at 4:00 that afternoon, the female was seen again in apparent courtship flight with a male less than one-quarter of a mile from the original nest site. Her second nest was initiated 5 days after the destruction of the first nest; 3 eggs were laid and incubated for 1 week when the nest was destroyed by a skunk. This hen was never sighted again.

This sample proved too small to obtain the desired information on renesting. Although it did establish the fact that renesting occurred at Ogden Bay Refuge, quantitative data on the extent of renesting and the interval between nests were lacking. Sowls believed that there was a minimum interval of 4 days. Both of the above observations were in agreement with this but no conclusion is offered at this time for such limited data.

The renesting study extended from April 26 to July 6. This may have influenced the results in view of the possibility that some of the birds were already renesting when trapped and robbed of their eggs.

Field observations on courtship flight as described by Sowls furnished a better clue to the incidence of renesting than did the renesting study. The first observation of this type was recorded on May 2 and the last a month later, June 2. On May 8, another female was observed "teasing" a drake, and on May 25, 3 instances of renesting courtship were recorded at different points on the study area.

Sowls' (1949, p. 267) description of renesting courtship could hardly be improved upon and deserves repeating in this work:

> In all cases where courtship was observed from its beginning it was initiated by the hen. In the pintail a lone hen

Figure 39. A ditch penetrating some excellent nesting cover at Ogden Bay Refuge. Ditch retains water until late in brood-rearing season.

Figure 40. Solid stands of alkali bulrush (Scirpus paludosus) are of little value as pintail nesting cover but provide a bountiful supply of food and are utilized to some extent as brood cover.

> utters a teasing call resembling "yank-yank-yank" and throws her head back along her side. This teasing call may have the same effect as the call Heinroth terms the incitement note in the European pintail and describes as "rarrerer". Following a series of calls and head throws, the hen makes a towering flight, continuing her teasing calls intermittently. As she makes her calls in the air she hunches her body, draws her wings in and drops momentarily in mid-air as she draws her head back. I have seen pintail hens climb to what appeared to be over a thousand feet above the prairie on such flights. As the flight begins a number of drakes pursue, the number decreasing as many of them drop out until at last one alone remains with her.

The only addition to this description from Ogden Bay observations was that frequently one of the pursuing males swept under the female in flight to rise sharply just in front of her. This was always followed by the hunching and momentary drop of the female described by Sowls.

BROODS AND BROOD REARING

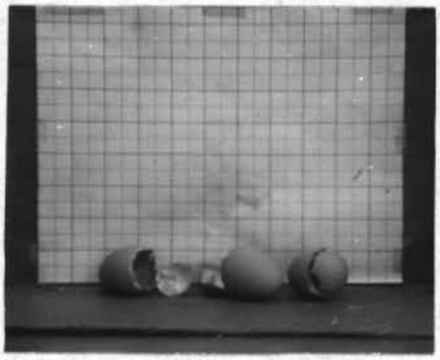
Techniques

The purpose of making brood counts was to obtain data on survival and brood decline, not to evaluate production directly from such counts. Toward this end, broods were tallied in 3 age classes, the system now in common use (Crissey, et al, 1949). In 1951, weekly counts were made over the refuge by (1) driving along dikes, (2) canoeing the inner channels, and (3) travelling on foot through the marsh along transect lines. The latter method was very unsatisfactory; in the majority of cases the female would flush and her brood never be sighted in the vegetation. Rarely when the brood was seen could the observer be sure that all of the individuals had been counted. Consequently, only dike-line counts and those made by canoe were attempted in 1952. The overall result was a small sample for the 2 years -- a total of 53 broods containing 311 ducklings. Only those broods which were intact, accompanied by a female, and unalarmed were counted to reduce the possibility of missing individuals which had scattered. Further reason for the small sample will be noted in the discussion of brood cover.

The highest number of pintail broods counted in 1 day was 7 on July 10, 1952. This count included an equal number of Class I and Class III broods, occurred 5 weeks from the middle of the 1952 hatching period, and was believed to represent the approximate peak of the brood season.

Eggs collected during the renesting study were hatched in an incubator and the young kept in captivity until flying age was attained. Weekly observations and photographs of these birds yielded information

(a) The incubator



(b) Pintail egg shells from incubator hatch

(c) 1 day old

(d) 1 week old

(e) 2 weeks old

Figure 41. Growth and development of captive-reared pintails. The smaller squares in the background are $\frac{1}{2}$ inch on a side.

(f) 3 weeks old

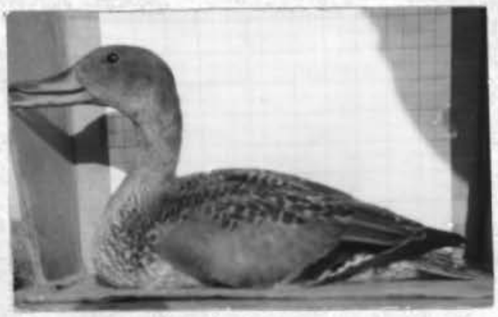
(g) 4 weeks old

(h) 5 weeks old

(i) 6 weeks old

(j) 7 weeks old

(k) 8 weeks old



(l) 9 weeks old male

(m) 9 weeks old female

Figure 41 cont'd. Growth and development of captive-reared pintails on feather development and growth which was found useful in estimating the age of wild-reared broods.

Captive ducklings were fed a ration of "chick starter" to which ground egg yolk was added, and provided with a supply of duck weed (Lemna minor). At approximately 4 weeks of age, commercial rabbit pellets were substituted for the chick starter and by 5 to 6 weeks of age wheat was added. Ducklings were kept in a brooder until 1½ to 2 weeks old, depending on the weather. A light in the brooder attracted insects at night which supplemented the diet of the birds; mosquitos and moths were run down and devoured by ducklings only a day and a half old.

Larger ducklings would harass and eventually kill a smaller bird. Consequently, birds were separated by size classes until the smallest were half grown; by that time the larger birds paid little attention to the smaller ones.

Brood cover

Adding to the difficulty of brood counts, particularly of Class I birds, was the tendency of the female pintail to keep her young in heavily vegetated cover. At Ogden Bay Refuge, large areas of cattail (Typha spp.) and alkali bulrush (Scirpus paludosus) in shallow water furnished excellent concealment. Equally acceptable were the many shallow ditches overgrown by or filled with smartweeds (Polygonum spp.), cutgrass (Leersia oryzoides), duck potato (Sagittaria spp.), saltgrass (Distichlis stricta), and weeds. Even when found on the deeper channels, pintails clung to the margins and were the first to disappear into the bordering vegetation when alarmed. As if becoming increasingly independent with age, older broods were seen more frequently on open water than were downy young.

Ditch banks, muskrat houses, nearly any dry spot close to water and escape cover are utilized by the female in brooding her young. If found while brooding, the female excitedly attempts to draw the intruder away by feigning injury, and the young remain huddled together or move en masse into the water and vegetation to await the return of the parent.

Parental care and the brood formation

Bent (1951, p. 148) wrote:

> The male does not, I believe, wholly desert the female during the process of incubation and he assists somewhat in the care of the young, though he is not as bold in their defense.

Such assistance by the male was observed only once during this study and was believed to be more rare than suggested by Bent. This single incident was recorded by the writer on a backwater arm of the Little Bear River west of Logan, Utah, on May 20, 1951. Both male and female flushed together from the weedy border of the stream, but the female lit again and moved through the vegetation quacking loudly and dragging both wings. The male maintained flight all the time, circling the female about 50 feet above the ground. Not sighting the brood immediately, the investigator moved on, accompanied by both adults until he was 100 feet beyond the point where the birds had first flushed. Returning later by the same route, both birds met the investigator where they had left him 15 minutes earlier and resumed their former antics. A brood of 5 downy young was located when the female flew up and dipped low in flight over the ducklings. Although the female approached to within 15 feet of the intruder at times, the male never came nearer than 50 feet. Nor did he alight although he imitated the activities of the female when she was flying.

Munro (1944) expressed the belief that pintails maintain the brood

Table 34. Mortality in pintail broods at Ogden Bay Refuge - 1951 and 1952

Age Class	Broods Observed	Juveniles Observed	Ave. Brood Size	Mortality Between Classes (percent)	Percent Brood Decline*
Hatch	--	---	7.0		
I	19	116	6.1	13.0	
II	20	119	5.9	3.3	
III	14	76	5.4	8.5	
Total	53	311	---	---	22.9

* Calculated as (Ave. Hatch - Class III)/Ave. Hatch

Table 35. Calculated pintail production per hundred habitat acres. Ogden Bay Refuge. 1951 and 1952. (Data from Tables 25, 29, 30, 32, and 34)

Cover Type (See Table 18)	Nests per Hundred Acres		Nest Success		Average Hatch in Successful Nests		Ducklings Produced		Brood Survival		Juveniles Produced to Flying Age
1	13	x	0.69	x	7.1	=	64	x	.77	=	49
2	1		0.50		3.0		2		.77		1
3	2		0.70		7.0		10		.77		8
5	6		0.33		8.0		16		.77		22
6	14		1.00		7.5		105		.77		81
7	50		0.44		7.0		154		.77		119
8	43		0.64		6.7		28		.77		22
10	14		1.00		8.0		112		.77		86
12	15		1.00		4.0		60		.77		46
13	120		0.86		7.6		784		.77		604
15	175		0.80		5.7		798		.77		614
17	50		0.67		6.5		218		.77		168
20	24		1.00		6.0		144		.77		111
Ave.*	15	x	0.71	x	7.0	=	75	x	.77	=	58

* Nests per 100 habitat acres

formation during the autumn migration. Banding operations at Ogden Bay made this an appealing idea at times but no supporting evidence was ever obtained. Local brood counts indicated that such a condition existed up to flying age at least. No mixing of broods or mixed-age broods were positively identified as such.

Of individual interest was a brood of 8 Class III pintails observed at Ogden Bay on June 19, 1952. Three of the ducklings were run down by foot, banded, and released after noting that primary feathers were protruding $1\frac{1}{2}$ to 2 inches from their sheaths. The same brood (identified by the banded members) was again sighted on June 23, 2 miles south of the point of initial observation. At this time 7 of the birds were flying and the female still attended the brood.

Growth and feather development

The weight of 25 newly hatched ducklings averaged 26.77 grams with a range from 19.05 to 30.95 grams. Subsequent measurements of weight were not attempted since it was felt that hand feeding would render such data valueless.

Figures 41c to 41m illustrate the growth and feather development to a certain extent, but a few additional notes may be helpful.

By 2 weeks of age, the sheaths of forthcoming tail feathers, scapulars, and breast feathers, as well as those on the sides of the body and ventral surface of the wings, are beginning to emerge and have reached one-quarter of an inch in length in some birds. Such development is not noticeable, however, unless the bird is in the hand.

By 3 weeks of age, tail feathers have emerged about three-quarters of an inch from the sheaths which have also elongated increasing the apparent length of the whole. These feathers, which are visible in the field with a pair of binoculars, along with a somewhat ragged appearance due to the emergence here and there of groups of contour feathers, denote a bird of at least 3 weeks in age. This is a fortunate happenstance from the standpoint of brood counts, since it represents a definite separation between Class I broods (1/3 grown) and Class II broods (1/3 to 2/3 grown).

When 4 weeks old, the tail feathers have reached a length of $1\frac{1}{2}$ to 2 inches, and flight feathers are emerging. The head is almost fully feathered but the neck is still shaggy with down. A trace of white down is still to be seen over the rump. The nail of the bill has turned black.

At age 5 weeks, flight feathers and their sheaths have attained a length of 3 inches, while tail feathers are nearly the same length and well-formed. With the exception of the neck, where down remains unhidden by contour feathers, the body is now well feathered and quite trim in appearance. Bill spotting is noticeable in the females and the dull speculum on their secondary wing feathers is quite well developed. Males do not yet exhibit a complete speculum. The pintail is now two-thirds grown.

Six-weeks old birds and older are designated as Class III broods. Younger Class III and older Class II broods are more difficult to separate than are Class I and Class II broods. Six-weeks old birds are completely feathered in juvenal plumage and males are now showing color and a white distal border to the speculum. Females may voice their first quack.

Although several of the captive birds did not fly until 8 weeks out of the egg, the writer suspected that this was partially due to a rather sedentary existence in the pen, and that only the "runtiest" of wild-reared birds failed to gain wing in their seventh week.

Two drakes, retained until 9 weeks old, began the post-juvenal molt and showed white breast feathers of the first winter plumage when released. The 2 center tail feathers were the first to be lost in each case.

Brood mortality

Heaviest losses were sustained in the youngest age class and an overall decline of 22.9 percent was realized. This study furnished no direct evidence of brood mortality among pintails; predation on pintail broods was never observed, nor were any dead ducklings or the remains of such ever found.

Odin (1951) discussed the California Gull as a predator on broods at Farmington Bay, Utah, and Bizeau (1951) found the marsh hawk (*Circus cyaneus hudsonius*) to be the greatest offender at Gray's Lake, Idaho. The writer witnessed the attack of a duck hawk upon a redhead brood in which the prey (a single duckling) was snatched from the surface of the water. Another interesting observation was that of a gopher snake swallowing a young willet (*Catoptrophorus semipalmatus inornatus*). Three ducklings in a brood held captive by the writer were killed by a horned owl. Undoubtedly, the potential predators in the area took their toll of ducklings, and an occasional bird was separated from the brood to die from chilling.

The rather high loss to Class III ducklings is more difficult to explain. The writer suspects that very little of the 8.5 percent decrease in this class is the result of mortality - that the majority of it is due to some individuals having gained flight sooner than others and separating themselves from the brood formation.

Since no flightless juveniles were observed or handled during the botulism season, it seemed very likely that this disease was not a factor in brood mortality.

Production estimates

Table 34 summarizes the brood count data and reveals an average brood survival of 5.4 juveniles per female. This is an estimate of average production per female.

A survival of 77.1 percent from the average hatch to Class III individuals meant that 77 of every 100 ducklings which hatched reached the flying stage. This figure was used to calculate average production per unit of area. In Table 35, this estimate is 58 juveniles produced per 100 habitat acres, and is shown in the row for totals.

Table 35 also reveals production per unit of vegetation with each cover type representing a separate unit. Data for these calculations are taken from the tables showing nesting density, nest success, and average hatch in each cover type.

Discussion

Acknowledging the possible effects of small sample size, the production estimates may be analyzed as follows:

1. Estimates of pintail production as given herein represent minimums since they are based on nests actually located and broods seen. No correction factors have been applied to account for nests which were not found nor for any renesting which occurred.

2. Average production of pintail ducklings per female is useful as an indication of what may be expected from each successful nest. This figure might be applied to counts of breeding pairs to obtain an estimate of production on an area. Such an extension of the data seemed

inadvisable to the writer, however, until the effects of renesting on counts of breeding pairs are better understood.

3. Extension of any of these estimates to another area must be governed by a careful comparison of plant composition and interspersion, interspersion of plants and water, and relative breeding populations. Moreover, production on a given area for 2 years or 2 periods is of limited comparative value unless changes in the above factors are considered.

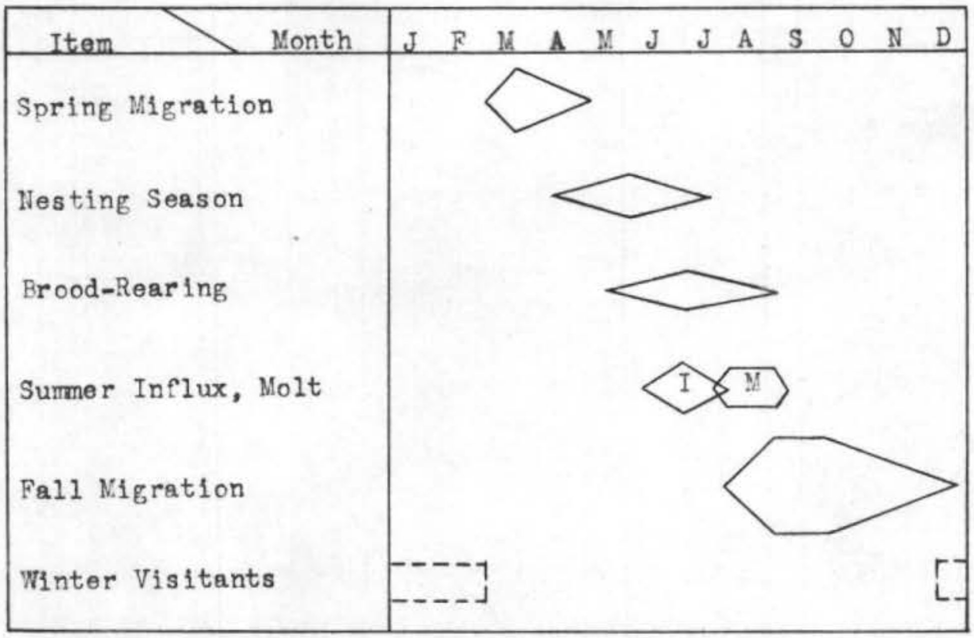


Figure 42. Seasonal life history chart of the American Pintail in Utah

DECIMATING FACTORS

Predation

The list of predators at Ogden Bay Refuge is typical of many waterfowl areas in Salt Lake Valley and certainly does not lack for members. Table 36 is not necessarily a complete list, and the status of the predators listed in this table undoubtedly changes from one locality to another.

Habits of the individual waterfowl species subject them to varying degrees of pressure, the pressure being conditioned by season and relative abundance of the predators. Similarly, characteristics of a marsh may favor a predator in one area and the prey in another.

This brings the subject of predation and predator pressure down to specific problems or a local basis, which seems to be where it belongs as far as the pintail in this area is concerned. A great many hours were spent afield with potential predators observed on all areas. Only 3 observations of predation on any and all species of waterfowl, and the lack of evidence of predation on the pintail, indicated a low incidence of such losses. The conclusion to be drawn from this and the foregoing treatment of nest destruction was that only egg predators were influential in reducing the pintail population.

Diseases and parasites

A study of diseases and parasites in the pintail, with the exception of botulism losses, was a minor phase of this study and received comparatively little attention. Investigations consisted of a number of post-mortem examinations upon birds found dead or sick and upon a few

Table 36. Observed predators and potential sources of predation pressure on waterfowl at Ogden Bay Refuge

Predator	Status[1]	Predator Pressure		
		Eggs	Birds	Both
Observed				
Skunk, Common	Common	X		
Gull, California	Abundant			X
Hawk, Duck	Scarce		X	
Owl, Horned	Rare		X	
Potential				
Badger	Rare	X		
Cat, House	Scarce		X	
Coyote[2]	Rare	X?	X	
Dog	Scarce	X?	X	
Mink	Scarce			X
Weasel	Common			X
Eagle, Bald	Rare		X	
Eagle, Golden	Rare		X	
Falcon, Prairie	Scarce		X	
Hawk, Marsh	Common		X	
Heron, B.-C. Night	Abundant			X?
Magpie	Common	X		
Raven	Scarce	X	X?	
Snake, Gopher	Scarce			X

1. Rare - may or may not be seen during season
   Scarce - present in small numbers
   Common - regularly present in moderate numbers
   Abundant - present in large numbers
2. Very rare in area, never seen by writer

collected in the area, an attempt to examine blood smears, and field observations.

Botulism. During 1951 and 1952, the writer participated in the botulism control program conducted by state personnel. Birds which were picked up were tallied by species, sex, and age insofar as time permitted and characteristics were recognizable. Losses in 1951 were only slightly above what might be considered average for Salt Lake Valley and were estimated at 10,000 birds of all species (Nelson, 1951). First losses in 1951 were noted early in August, but not until the last of that month did they become sufficiently large to warrant a pickup in the units at Ogden Bay Refuge. The course of the outbreak permitted a fairly accurate tabulation of data at all times.

The summer of 1952, on the other hand, established a record for dryness and an unusually large concentration of birds arrived in the area early in August. At Ogden Bay Refuge, this early migration reached a peak of 867,000 birds by August 30, 2 weeks to a month in advance of the normal peak. As a result of this and low water supplies, the botulism outbreak was explosive and an estimated 50,000 birds were lost in the Salt Lake Valley (Nelson, 1952). Pickups became necessary early in August of 1952 and major losses occurred from August 15 to September 15. Sportsmen in the state were a great help to regular personnel in cleaning up some areas; in many instances, however, the combined efforts of workers resulted in so many birds being picked up that a total count of losses was the only data obtainable.

Pintails which succumb to this disease in Utah exceed all others in number. Attempts to correlate the percent of pintail losses in the total loss to the percent of pintails in the total population are difficult. In the first place, it is impossible to know if the birds being picked up with botulism at any one time are a portion of the current population in the area or of that which was present 2 weeks to a month earlier. In the second place, the number and percent of pintails in the population fluctuate appreciable during the botulism season.

In Table 37, the data for "waterfowl present" came from an average of bi-monthly censuses during the botulism outbreaks. This procedure assumed that such censuses were reasonably valid indications of population trends. Further assumptions were (1) that all individuals had an equal opportunity to contract the disease and (2) that all individuals were equally susceptible to the disease.

The expected losses were determined by proportioning the total number found afflicted according to the percent of the total population represented by each category.

Table 37 shows that pintail losses exceeded expectations in both years of the study while losses to other species were below expectations, and that all deviations from expected values were very highly significant at the 1 percent level of significance.

Field observations provide a clue to the variation in mortality. Shallow waters and "feather" edges appear conducive to the development of botulism, and pintails are more likely to concentrate on such areas than are some of the other species represented. The sequence of events which helps to explain Table 37 may be listed as follows:

1. Habitat and environmental conditions become ideal for an outbreak of botulism in late summer.

2. A wave of migrating pintails concentrates in this setting,

Table 37. Comparative mortality of pintails from a sample of botulism afflicted birds in the Great Salt Lake Valley - 1951 and 1952

	Composition of waterfowl (percent)		Number Afflicted		Chi-square Values[2]
	Present	Afflicted	Found	Expected[1]	
			1951		
Pintail	46.7	63.2	4934	3646	455.0
All Others	53.3	36.8	2873	4161	398.7
Totals	100.0	100.0	7807	7807	853.7
			1952		
Pintail	53.4	64.7	6320	5216	233.7
All Others	46.6	35.3	3448	4552	267.8
Totals	100.0	100.0	9768	9768	501.5

1. From percentage composition of waterfowl present
2. For one degree of freedom a figure greater than 6.63 indicates that there is less than one chance in a hundred of deviations between observed and expected values being due to chance. Hence, the above results show highly significant variations.

their number greatly exceeding that of any other species so that the percent of pintails in the population is temporarily increased.

3. Botulism losses increase sharply with a very high percent of pintails involved.

4. An outward migration of pintails and an influx of other species markedly reduces the percent of pintails in the population, although their number continues to exceed that of any other species throughout the outbreak.

5. The preceding event tends to hold the percent of pintails in the average population over the period of the outbreak at a low level. Although their percent of total losses is now also reduced, pintail losses continue to be high in number because of the large number of this species still present and the fact that they congregate in shallow water areas. This tends to keep the very high percent of pintail losses earlier in the season at a fairly high level. Therefore, the percent of pintails in the total losses is considerably higher than the percent of pintails in the average population over the period of the outbreak.

Botulism in Utah takes a heavier toll of adult than of immature pintails and greater numbers of males than of females. This is indicated in Table 10c from a sample of 3,778 pintails in 1951 and a sample of 3,506 in 1952. The implications of these data from the standpoint of pintail migration have been discussed in the section dealing with migration and populations.

On the basis of an estimated loss of 10,000 birds in 1951 and 50,000 birds in 1952, it was concluded that at least 6,400 pintails were afflicted in the former year while at least 32,000 succumbed in 1952.

In the summer and fall of 1942, losses in the same area mounted to 175,000 birds with pintails suffering the most (Cottam, 1947). Botulism is, therefore, a decimating factor of varying magnitude. On a local level, 32,000 botulism-afflicted birds is disheartening and of serious concern; however, to a species whose continental population ranks second in number, this loss may be interpreted as deplorable but not excessive.

Fowl cholera. Comparatively heavy losses to waterfowl from fowl cholera have occurred in California (Rosen and Bischoff, 1949 and 1950) and in Texas (Petrides and Bryant, 1951). Although these outbreaks have been noted prior to the northward migration, the disease has not been witnessed in birds along the migration route north of the California and Texas wintering grounds. Consequently, it was felt that sick birds of several species observed at Ogden Bay during the spring migration of 1952 might be suffering from fowl cholera.

Cultures from 5 such birds which were sent to the Veterinary Science Department at Utah State Agricultural College failed to show any Pasteurella organisms but revealed that all 5 birds were afflicted with botulism.

To the writer's knowledge, fowl cholera is unreported in Utah ducks. Dr. M. L. Miner of the above Veterinary Science Department reports a rather high incidence of cholera in domestic poultry.[1] It is surprising, therefore, that an outbreak has not occurred among waterfowl in the state; for the ubiquitous gulls, in their habit of frequenting dumps, farmland and poultry yards, could contract the disease in numbers and transfer it to the marsh. Due to the relative size of the pintail population in Utah, an outbreak of fowl cholera might be

1. Personal interview

expected to take a heavy toll of this species only when large populations of pintails are present.

<u>Parasites</u>. Fifty slides were prepared from blood samples taken from 50 pintails at Ogden Bay Refuge. These were to be examined for the occurrence of such blood parasites as <u>Haemoproteus</u>, <u>Leucocytozoan</u>, and <u>Microfilaria</u>, whose occurrence in waterfowl has been verified by other workers (Coatney, 1936 and 1937; Nelson and Gashwiler, 1941). Due to faulty technique on the part of the writer, however, the slides became valueless and the incidence of blood parasites in pintails was undetermined.

Tapeworms (Cestoidea, subclass Cestoda) were extracted from the intestine of 7 pintails in a sample of 15 which were examined. All birds were adults. The number of worms removed from any one bird varied from 2 to 8, but in no case did they completely obstruct the digestive tract. No other internal parasites were noted.

Externally, Mallophagan lice were to be found on practically all pintails. No serious effects which could be attributed to these parasites were noted in the many birds handled.

Leeches (Hirudinea) were occasionally found attached to pintails. For the most part, birds which were attacked were those afflicted with botulism and lying in a paralyzed condition at the edge of channels or in shallow water areas. The usual point of attachment for the leeches was the ventral surface of the body or the legs. Less frequently these annelids were found in the nasal cavities. Undoubtedly leeches were a secondary cause of death in some instances of this type, but it was suspected that they were insignificant to a normally healthy and active pintail.

Hunting losses

A sample of pintail losses during the hunting season was obtained from bag checks at 4 stations on 3 state areas - 2 at Ogden Bay Refuge, 1 at Farmington Bay, and 1 at Public Shooting Grounds. In 1951, checking stations were manned on these areas on every weekend (Saturday and Sunday) and on 2 of the remaining 5 week days; in 1952, the stations at Public Shooting Grounds and the North Run of Ogden Bay Refuge were operated only on weekends. Hunting data from Bear River Refuge were also made available to the writer.

The pintail is a favored bird among Utah hunters. At Ogden Bay Refuge, this species is usually taken in greater numbers than any other single species; at Bear River Refuge, the green-winged teal has supplanted the pintail in first place during the last 5 hunting seasons (Table 38). This is undoubtedly due to population density and species distribution on the hunting grounds, not to composition of the population alone. Selective shooting is practiced on some of the private gun clubs, but the majority of hunters take what comes their way and cannot distinguish one species from another.

Three factors pointed to a heavy kill of pintails in 1952: (1) production was reportedly high, (2) the length of the season was increased by 10 days over the 60-day season of 1951, and (3) the bag limit of 6 birds was modified to include 2 extra pintails, permitting a total of 8 pintails per man per day. In spite of this, weather and the pintail conspired to lower the kill of this species in 1952, and for the first time in the history of Ogden Bay Refuge the kill of green-winged teal exceeded that of any other species on that area.

Census figures (Table 5) revealed that an unusually large number of pintails reached the Salt Lake Valley earlier than usual in 1952, and that the majority of these birds moved on before the hunting opened. Furthermore, the early season was exceptionally dry, warm and sunny, while the second half was characterized by freezing conditions and very little open water. Later pintail migrants, therefore, funneled through the state rapidly affording little more than a passing shot to the hunter.

The proportion of pintails in the kill on all check areas averaged 23.2 percent in 1951 and 23.3 percent in 1952. These values were used in obtaining the total pintail kill on the check areas and over the entire state. In obtaining the total kill on check areas, the kill for week days which were not checked was averaged from the week days which were checked. Total statewide waterfowl kill was determined by the percent of the total kill which occurred on these check areas. The latter percentage was obtained by a sample card survey of duck hunters.

The calculated crippling loss to pintails of 24 percent must be considered a high figure because an unknown number of cripples were retrieved by hunters who were reluctant to admit that they did not personally shoot the birds. Since the average hunter was unable to identify the different species, it was necessary to assume that the species composition of unretrieved birds was identical to that of the hunters' bag.

Adding crippling losses to the tabulated kill brings the total pintail losses in the 1951 and 1952 hunting seasons to 60,260 birds and 51,636 birds, respectively.

A summary of hunting data with respect to the pintail is presented in Tables 14, 39, and 40.

Figure 43. Aerial photograph showing a concentration of 5,000 pintails at Ogden Bay Refuge in early August, 1951. The pintails' habit of massing in such shallow water areas probably makes them more susceptible to heavy botulism losses than some other species.

Figure 44. Cannon-projected net trap set up at a pintail loafing spot on a dike at Ogden Bay Refuge. Most pintails proved too wary for this trap.

Table 38. Comparison of pintail kill for 14 hunting seasons at Bear River Migratory Bird Refuge[1]

Year	Total Waterfowl Killed	Number of Pintails Killed	Percent of Total	Rank among Others
1939	11581	3477	30.2	1st
1940	15816	4023	25.5	1st
1941	23467	8829	37.8	1st
1942	16683	6413	38.4	1st
1943	16816	7549	44.9	1st
1944	17063	6304	32.0	1st
1945	17603	6952	39.6	1st
1946	10296	2868	27.8	2nd
1947	8390	2531	30.3	1st
1948	10715	3234	30.2	2nd
1949	10153	2717	26.8	2nd
1950	16225	4555	28.1	2nd
1951	16097	3834	23.8	2nd
1952	12993	3124	24.2	2nd

1. Complete enumeration of kill. Data supplied by Mr. V. T. Wilson, Manager.

Table 39. Calculated kill on check areas and computed statewide kill - 1951 and 1952

(a) Bag checks on check areas		1951	1952
Ogden Bay Refuge	All ducks	9261	13486
	No. pintails	2247	2451
	% pintails	24.3	18.1
Farmington Bay	All ducks	4271	5495
	No. pintails	773	1177
	% pintails	18.1	21.4
Public Shooting Grounds	All ducks	936	594
	No. pintails	248	177
	% pintails	26.5	29.8
Bear River Refuge	All ducks	16097	12993
	No. pintails	3834	3124
	% pintails	23.8	24.0
(b) Calculated kill on check areas			
Ogden Bay Refuge	All ducks	30286	26700
	No. pintails	7359	4832
Farmington Bay	All ducks	12523	8365
	No. pintails	2266	1790
Public Shooting Grounds	All ducks	2290	2220
	No. pintails	606	661
Bear River Refuge	All ducks	16097	12993
	No. pintails	3834	3124
(c) Computed statewide kill from kill on check areas			
Statewide	All ducks	209468	178720
	Pintails (%)[1]	23.2	23.3
	Pintails (No.)	48597	41642

1. Averaged from check areas

Table 40. Calculated crippling losses among pintails during the 1951 and 1952 hunting seasons

(a) Check areas		1951	1952
Ogden Bay Refuge			
	Total ducks unretrieved	6711	6633
	Percent pintails	24.3	18.1
	Pintails unretrieved	1810	1200
Farmington Bay			
	Total ducks unretrieved	3047	1852
	Percent pintails	18.1	21.4
	Pintails unretrieved	551	396
Public Shooting Grounds			
	Total ducks unretrieved	360	502
	Percent pintails	26.5	29.8
	Pintails unretrieved	95	149
	Total pintails unretrieved	2456	1745
	Total pintails killed	10231	7283
	Percent unretrieved	24.0	24.0

(b) Calculated statewide crippling loss		
Statewide pintail kill from Table 39	48597	41642
Percent unretrieved	24.0	24.0
Calculated statewide pintail crippling losses	11663	9994

Lead poisoning

Because of very recent work on the incidence of lead shot in Utah waterfowl (Heuer, 1952), lead poisoning received very little attention by the writer. The technique of fluoroscopic examination for lead shot in the tissues and gizzards of waterfowl was observed in assisting Heuer for one day at Bear River Refuge. Heuer's work, involving an examination of 2,776 pintail gizzards from a total of 7,635 gizzards of all species, supplied the following information: (1) shot was found in 7.9 percent of all pintail gizzards, and (2) the percent with ingested lead increased sharply during the hunting season. Birds examined in the summer showed an incidence of 0.6 percent; during the fall, ingested lead was found in 5.8 to 10.0 percent of the birds examined.

Frazier (1949) examined 495 birds from Bear River Refuge and 300 from Ogden Bay Refuge, and found ingested lead in only 1 pintail.

In some of the earliest research on lead poisoning, Wetmore (1919) found that one pellet of Number 6 shot might constitute a lethal dose and that 6 shot of this size were always fatal.

Cottam (1939) and Bellrose (1951) suggested that feeding habits were important to the incidence of ingested lead. The inference from their writing was that pintails were more susceptible to lead poisoning than some other species because of their habit of digging deep into the bottom mud with their bills.

Bellrose (1951, p. 132) advanced the theory that lead poisoning reduced the motility of afflicted birds making them more vulnerable to hunters. Therefore, some of the decimating effects of lead poisoning were absorbed in the hunters' bag, becoming a part of the planned harvest. This theory implied that the incidence of lead poisoning in

Utah waterfowl as determined by Heuer (7.9 percent) was too high; for if lead poisoning increased the vulnerability of the ducks to hunters, a sample of gizzards during the hunting season would be expected to show an increased incidence of ingested lead not representative of the entire population.

It is concluded that lead poisoning is relatively unimportant to pintails in Utah except during the fall when populations are high and a large amount of expended shot is readily available. As a decimating factor, its effects may be substantially reduced by the kill during the hunting season. It must be remembered, however, that the effects of lead poisoning are cumulative. This means that one shot taken by a pintail in Alberta makes a second one picked up a little later in Utah all the more important. As indicated by Elder (1950, p. 501), lead poisoning is a local problem varying in importance from one area to another and widespread samples over the range of the species are needed.

Discussion

In Utah, egg predators and flooding were the only 2 decimating factors of known importance to pintails raised within the state. While very little predation on any species was actually witnessed, a wide variety of potential predators was found on all areas studied.

The greatest single decimating factor in both years of the study, to the population as a whole, was the hunting loss. Being a planned harvest of a surplus crop, such losses were not to be considered detrimental or wasteful to the perpetuation of the species. Crippling losses seemed deplorable. As calculated herein, such losses were admittedly high; however, instances of crippling observed by the writer indicated a widespread lack of judgement among many hunters and poor sportsmanship among a few. A program of hunter-education would benefit the sport and the species.

Botulism losses constituted the greatest waste of pintails encountered during the study. An exceptionally heavy loss in Utah in 1952 was not considered excessive in view of the abundance of birds in the area at the time of the outbreak. Nevertheless, the total loss, including a superior proportion of pintails, was nearly equivalent to a normal season kill of pintails alone in Utah; if a reduction of equal magnitude were imposed upon the statewide kill by legislation, some 32,000 wildfowlers would be extremely dissatisfied.

FOOD HABITS

Techniques

Food habits research was limited to an analysis of gizzard contents. During the 1951 hunting season, gizzards were collected from hunters at the checking station or at their homes, and from persons who made a business of feathering and drawing birds for the sportsmen. Seventy-five of these were examined. Twenty birds, collected in June and July of 1952, supplied material for an analysis of summer food habits. The fact that all gizzards were collected from Salt Lake Valley and birds shot in Utah did not, of course, delimit the area in which the food was acquired.

Gizzard contents were measured by volumetric displacement and a record of frequency of occurrence was kept for each food item as well. Identification of items was based upon comparisons with photographs, seed collections, and herbarium specimens. Professor Arthur Holmgren, Curator of the Intermountain Herbarium at Utah State Agricultural College, was of tremendous assistance to the writer in performing the latter task. All unidentifiable material was included in the category termed miscellaneous.

Utilization

The results of the analyses are summarized in Tables 41 and 42. An analysis of the utilization of all of the food items listed in these tables is of value to management in a given area. For the purpose of this study, however, the first 3 items of plant food are doubly important in the diet of the pintail - they are utilized most frequently, and they are present in greater bulk than any other item in the list.

The hypothesis that pintails make greatest use of those food items which are present in greatest quantity appears well supported by the food habits data for the fall period but refuted by the summer data. However, if the food were acquired in the Salt Lake Valley, the effects of hunting pressure on feeding habits must be recognized. At Ogden Bay Refuge, this pressure frequently causes pintails to "raft" in the center of the large refuge lakes where they are comparatively inaccessible. These lakes are near-solid beds of sage pondweed. During the night hours the birds become dispersed over the marsh and pick up a variety of food items.

During the summer, food habits are limited by seasonal availability and a preference for particular items is more likely to be indicated. An index to preference might be disclosed through a detailed quantitative analysis of availability and utilization which is not included in this work.

Kortright (1943) considered the pintail diet to consist of nine-tenths vegetable food and one-tenth animal food; Bent (1951) reported a similar ratio. According to Martin, Zim, and Nelson (1951), utilization of animal food increased during the summer but did not exceed 14 percent of the total amount consumed in any season. On the basis of 14 gizzards examined in Washington state (Yocum, 1951), the fall food of pintails in that area included less than 0.1 percent animal food. Food habits research by the writer revealed that animal food constituted less than 1.0 percent of the total food in Utah.

Food habits of juvenile pintails in Utah was not a part of this study. Bent (1951) indicated a high utilization of soft insect and

Table 41. Summer food items of 20 pintails collected at Ogden Bay Refuge in 1952

Item	Food Rating[1]	Frequency of Occurrence	% of Total Vol.
Plant food			51.57
Zannichelia palustris	Good	10	46.52
Carex spp.	Fair	11	1.42
Eleocharis spp.	Good	10	1.16
Distichlis stricta	Fair	6	.77
Polygonum lapathafolium	Excellent	7	.39
Potamogeton pectinatus	Excellent	7	.39
Ruppia maritima	Excellent	4	.20
Polygonum persicaria	Fair	4	.18
Bromus spp.	Poor	2	.13
Animal food			.61
Insecta		6	.59
Gastrapoda		2	.01
Miscellaneous			11.93
Grit			36.30

1. From Martin and Uhler (1939)

Table 42. Fall food items of 75 pintails shot in Utah - 1951

Item	Food Rating[1]	Frequency of Occurrence	Percent of Total Volume
Plant food			64.23
Potamogeton pectinatus	Excellent	70	26.89
Scirpus paludosus	Excellent	43	12.57
Scirpus acutus	Excellent	28	6.63
Zannichelia palustris	Good	8	6.22
Ruppia maritima	Excellent	17	4.09
Carex spp.	Fair	15	2.82
Polygonum lapathafolium	Excellent	5	1.39
Distichlis stricta	Fair	33	1.14
Scirpus spp.	Excellent	3	.93
Hippuris vulgaris	Fair	6	.84
Polygonum persicaria	Fair	14	.38
Amaranthus retroflexus	Fair	5	.33
Animal food			.67
Insecta		8	.49
Gastrapoda		5	.17
Crustacea		2	.01
Miscellaneous			11.28
Grit			23.48

1. From Martin and Uhler (1939)

6

aquatic animal food by very young birds. Birds hatched in an incubator by the writer were observed to feed avidly upon mosquitos (Diptera) and small moths (Lepidoptera) when 1 to 2 days old, and upon duckweed (Lemna minor) when less than a week old. Munro (1944) reported on 3 downy young in British Columbia whose gullets were filled with damselfly nymphs (Odonata). In general, brood-rearing areas in Utah abounded in all of these food items.

Discussion

From this study it is concluded that the availability of food is no problem to pintail populations in Utah under normal conditions. In fact, the wide variety of items on the major waterfowl areas, and the profound abundance of such excellent foods as pondweeds and bulrushes, is undoubtedly a major factor in holding hordes of pintails in the state during the fall and, to a lesser extent, in the winter. Rarely would the demand for food be likely to exceed the supply.

CONCLUSIONS

To the pintail population as a whole, Utah is of greatest value as a resting and feeding area during migration; the vast numbers of this species which pass through Utah attest to the importance of the state to a considerable proportion of the continental population. Pintail utilization of Utah marshes for molting, nesting, and wintering grounds, while subordinate to that of migration, are deemed important in approximately this order.

Conversely, pintail migration is big business to the economy of Utah. To ascribe all of the aesthetic appeal of waterfowl, and the widespread popularity of Utah gunning (both of which attract a vast number of persons to the state) to the pintail alone would be a gross falsehood. Nevertheless, the distinctive and graceful appearance of this bird, its superlative numbers during much of the year, and its popularity with wildfowlers demand recognition of its importance as one of the factors contributing to the economic welfare of the state.

The production of pintails in Utah is intermediate in comparison with that of other nesting species. Large scale attempts to increase pintail nesting in this area are probably unwarranted in view of 3 factors: (1) existing areas are believed capable of supporting higher densities than now exist on them, (2) the appeal of more northern breeding grounds appears hereditary in the species, and (3) the continental population is large and apparently in no immediate danger from decimating factors.

Botulism losses are currently one of the greatest enigmas to management of the species in Utah. As a result of large numbers during the botulism season and a fondness for areas of high botulism potential, pintail losses to this disease exceed those of any other species. The need for continued epidemiological research is evident. Dispersing heavy concentrations from the most troublesome areas might prove a temporary control technique of some value.

In normal years the most serious threat to local production is predation by the California Gull. The importance of reducing losses of this kind is considered to supercede that of other methods of increasing production in the marshes adjacent to the Great Salt Lake.

Food production, in volume and variety, is considered excellent in the areas receiving greatest utilization, and very favorable over the state as a whole. The fact that some of the best waterfowl hunting in the country is available in Utah is traced to an abundance of food and the location of the state with respect to 2 flyways and a major route of migration.

SUMMARY

1. To obtain a better understanding of the importance of the state to one of its most abundant waterfowl, a study of the pintail duck was conducted in northern Utah from March, 1951, to December, 1952. Major emphasis was focused on migrations and populations, production and decimating factors within the state.

2. Pintails, travelling to and from their major nesting grounds in Canada and Alaska, were among the earliest migrants reaching Utah. Spring migrants moved through the state rapidly in two waves, the first showing a preponderance of males and the second showing an approximately balanced sex ratio. The earliest southward migrants were adults, congregating on northern Salt Lake marshes for completion of the post-nuptial molt and flightless period. A pronounced differential movement of sexes and age classes in the protracted fall migration resulted in greatest losses to adult males during the botulism and hunting seasons. Immature birds of both sexes were the first to move to major wintering grounds in the Pacific coast states and on the Gulf coast, and adult females appeared to be among the last to move.

3. Returns from Utah-banded birds indicated a wide dispersal in the first year subsequent to banding. There was limited evidence that (a) a direct cross-country movement to the Gulf coast occurred, (b) that birds raised in Utah were not harvested in their first year within the state, (c) that some reverse fall migration occurred, and (d) that a round-robin pintail migration involving more than one flyway existed. Pintails from widely scattered regions reached Utah; considerable

movement from Alaskan breeding grounds through the prairie provinces to Utah was indicated.

4. Except in the coldest weather when little open water was available, pintails spent the winter on northern Utah marshes. Sex ratios indicated considerable shuttling about and movement in and out of the state during this season.

5. The number of pintails which nested in Utah was intermediate compared with other species, ranking fourth among 7 nesting species on the special study area. Nesting densities were lower than was possible under the apparent tolerance of the species. Rushes, spikerushes, and bassia showed the greatest utilization as nesting cover, and a high value of interspersion and edge effect was indicated. Nesting reached a peak during the second week of May and peak hatching was attained during the first week of June. Pintail clutches averaged 8.3 eggs from which an average of 7 ducklings hatched. The California Gull and common skunk were the greatest factors in lowering production; nest parasitism and "dump" nesting occurred rather infrequently with no serious effects. The proclivity of the pintail for dry, exposed nest sites was considered responsible, in large measure, for an average nest failure of 29 percent; average nest and egg success were very satisfactory, however, according to standards set forth by Kalmbach.

6. Pintail renesting occurred in Utah but its incidence and effects on counts of breeding pairs was undetermined.

7. An overall brood decline of 22.9 percent was realized, and major losses occurred soon after hatching. Exact causes of the decline were undetermined, but predators and separation from the brood formation were suspected as part of the cause. Sample size was undoubtedly

a factor, too. Production, based on survival to flying age, was estimated at 5 birds per nesting female or 58 ducks per 100 habitat acres. In terms of individual cover types, highest production was attained in bassia.

8. Hunting and botulism were the greatest decimating factors within the state to the pintail population. Although hunting losses exceeded botulism losses in number, the latter were by far the more serious from the standpoint of wasted wildlife. Pintail losses to this disease were out of proportion to the relative population during outbreaks. This seemed to result from the habit of congregating in areas of high botulism potential. Lead poisoning was considered serious only during the fall, and even then there was a possibility that much of its harmful effects were absorbed in the hunting season harvest. Parasites, on the basis of very small samples, were considered inconsequential.

9. Food to the pintails' liking was considered abundant and varied in Utah; this was undoubtedly a major factor in holding large numbers of pintails in Utah during the fall and, to a lesser extent, during the winter.

10. It was concluded that Utah is of major importance to the pintail as a resting and feeding area during migration and that attempts to increase pintail nesting within the state were probably unjustified. Attempts to reduce botulism losses and to increase production were deemed major concerns in present management of the species. It seemed evident that Utah derived a reciprocal benefit from the abundance of the pintail within the state as a result of the aesthetic appeal of this bird to tourists and its gunning appeal to sportsmen.

LITERATURE CITED

American Ornithologists' Union. 1931. Check-list of North American Birds. 4th Ed. Lancaster, Pa.: American Ornithologists' Union.

_______ 1944. Nineteenth Supplement to the A. O. U. Check-list of North American Birds. Auk 61(3):441-464.

_______ 1945. Twentieth Supplement to the A. O. U. Check-list of North American Birds. Auk 62(3):436-449.

_______ 1946. Twenty-first Supplement to the A. O. U. Check-list of North American Birds. Auk 63(3):428-432.

_______ 1947. Twenty-second Supplement to the A. O. U. Check-list of North American Birds. Auk 64(3):445-452.

_______ 1948. Twenty-third Supplement to the A. O. U. Check-list of North American Birds. Auk 65(3):438-443.

_______ 1949. Twenty-fourth Supplement to the A. O. U. Check-list of North American Birds. Auk 66(3):281-285.

_______ 1950. Twenty-fifth Supplement to the A. O. U. Check-list of North American Birds. Auk 67(3):368-370.

Anonymous. 1949. A report on Ogden Bay Refuge. Utah Fish and Game Bul. 7(9):3-5.

Anthony, H. E. 1928. Field book of North American mammals. 9th Ed. New York: G. P. Putnam's Sons.

Behle, W. H. 1943. Birds of the pine valley mountain region, southwestern Utah. Utah Bul. Univ. of Utah 34:1-85.

_______ 1944. Check-list of birds of Utah. Condor 46:67-87.

Bellrose, F. C. 1951. Effects of ingested lead shot upon waterfowl populations. N. A. Wildlife Conf. Trans. 16:125-133.

Bennett, Logan J. 1938. The blue-winged teal, its ecology and management. Ames, Iowa: Collegiate Press, Inc.

Bent, A. C. 1951. Life histories of North American wild fowl. Vol. I. New York: Dover Publications, Inc.

Bizeau, Elwood G. 1951. Factors affecting waterfowl production at Gray's Lake, Idaho. (M. S. Thesis, unpublished) Moscow, Idaho: University of Idaho.

Braund, F. W. and McCullagh, E. P. 1940. The birds of Anticosti Island, Quebec. Wilson Bul. 52(2):96-123.

Cartwright, B. W. and Law, J. T. 1952. Waterfowl banding 1939-1950 by Ducks Unlimited. Winnepeg, Manitoba: Ducks Unlimited.

Coatney, G. R. 1936. A check-list and host-index of the genus Haemoproteus. Jour. Parasit. 22(1):88-105.

_______ 1937. A check-list and host-index of the genus Leucocytozoan. Jour. Parasit. 23(2):202-213.

Cottam, Clarence. 1939. Food habits of North American diving ducks. U. S. D. A. Tech. Bul. 643.

_______ 1947. The puddle ducks of Utah. Utah Magazine. Pp. 20-23, 27-34. October, 1947.

Crissey, W. F. 1951. Status report of waterfowl. Washington: U. S. Fish and Wildlife Service. 39pp. (Mimeo.)

Crissey, W. F., et al. 1949. Waterfowl populations and breeding conditions - Summer 1949, with notes on woodcock and Wilson snipe. U. S. D. I. Special Scientific Report (Wildlife) No. 2. Washington: Fish and Wildlife Service.

Delacour, Jean and Mayr, Ernst. 1945. The family Anatidae. Wilson Bul. 57(1):3-55.

Dill, Herbert H. and Thornsberry, Wm. H. 1950. A cannon-projected net trap for capturing waterfowl. Jour. Wildlife Mgt. 14(2):132-137.

Dixon, W. J. and Massey, F. J. 1951. Introduction to statistical analysis. New York: McGraw-Hill Book Company, Inc.

Elder, Wm. H. 1950. Measurement of hunting pressure on waterfowl by means of x-ray. N. A. Wildlife Conf. Trans. 15:490-504.

Erickson, Arnold B. 1943. Sex ratios in ducks in Minnesota, 1938-1940. Auk 60:20-34.

Frazier, H. H. 1949. A study of the incidence of lead shot in ducks by fluoroscopy. Project 114: Utah Cooperative Wildlife Research Unit. Third Quarter.

Furniss, O. C. 1935. The sex ratio in ducks. Wilson Bul. 47:277-278.

Hardy, Ross. 1947. Utah's Book Cliffs and bird migration. Auk 64(2): 284-287.

Hawkins, A. S. 1940. Sex and age ratios in ducks. Research News, October, 1940. (Mimeo.)

Heuer, Wayne H. 1952. The incidence of lead shot in waterfowl of the

Pacific Flyway with special reference to the Great Salt Lake Basin. (M. S. Thesis, Department of Wildlife) Logan, Utah: Utah State Agricultural College.

Hochbaum, H. A. 1939. Waterfowl studies at Delta, Manitoba. N. A. Wildlife Conf. Trans. 4:389-394.

_______ 1944. The canvasback on a prairie marsh. Washington: The American Wildlife Institute.

Holmgren, A. H. 1948. Handbook of the vascular plants of the northern Wasatch. San Francisco: Lithotype Process Company.

Kalmbach, E. R. 1938. A comparative study of nesting waterfowl on the Lower Souris Refuge: 1936-1937. N. A. Wildlife Conf. Trans. 3: 610-623.

_______ 1939. Nesting success: its significance in waterfowl reproduction. N. A. Wildlife Conf. Trans. 4:591.

Kortright, F. H. 1943. The ducks, geese and swans of North America. Washington: The American Wildlife Institute.

Leopold, Aldo. 1946. Game management. New York: Chas. Scribner's Sons.

Lincoln, F. C. 1932. Do drakes outnumber susies? American Game 21: 3-4, 16-17.

_______ 1939. The migration of American birds. New York: Doubleday, Doran and Co., Inc.

Low, J. B. 1945. Ecology and management of the redhead, Nyroca americana, in Iowa. Ecol. Monog. 15:35-69.

_______ 1952. Great Basin, Central Rocky Mountain Region. Audubon Field Notes 6(4):260.

Low, Seth. 1949. The migration of the pintail. Migration of Some North American Waterfowl. U. S. D. I. Special Scientific Report (Wildlife) No. 1. Washington: Fish and Wildlife Service.

Mann, Grady. 1950. Reverse fall migration. Jour. Wildlife Mgt. 14(3): 360-362.

Martin, A. C. and Uhler, F. M. 1939. Food of game ducks in the United States and Canada. U. S. D. A. Tech. Bul. 634.

Martin, A. C., Zim, H. S. and Nelson, A. L. 1951. American wildlife and plants. New York: McGraw-Hill Book Company, Inc.

McIlhenny, E. A. 1940. Sex ratio in wild ducks. Auk 57:85-93.

Mills, Harlow B. 1951. Facts and waterfowl. N. A. Wildlife Conf. Trans. 16:103-109.

Munro, J. A. 1944. Studies of waterfowl in British Columbia. Pintail. Can. Jour. Res. 22:60-86.

Nelson, Noland F. 1940. Waterfowl food and cover plants in relation to the total soluble salt content of soil horizons on the Bear River Marshes in Utah. (B. S. Thesis, School of Forestry) Logan, Utah: Utah State Agricultural College.

_______ 1949a. Quarterly progress report. Federal Aid in Wildlife Restoration Act, July 1. Pp. 6-9. (Abstract)

_______ 1949b. Pacific Flyway reports for Utah. Nos. 5-8. U. S. Fish and Wildlife Service.

_______ 1950. Pacific Flyway reports for Utah. Nos. 9-12. U. S. Fish and Wildlife Service.

_______ 1951. Pacific Flyway reports for Utah. Nos. 13-16. U. S. Fish and Wildlife Service.

_______ 1952. Pacific Flyway reports for Utah. Nos. 17-20. U. S. Fish and Wildlife Service.

Nelson, E. C. and Gashwiler, J. S. 1941. Blood parasites of some Maine waterfowl. Jour. Wildlife Mgt. 5(2):199-205.

Odin, C. R. 1951. The effect of predation by California Gulls (Larus californicus Lawrence) on waterfowl production. (M. S. Thesis, Dept. of Wildlife) Logan, Utah: Utah State Agricultural College.

Peters, J. L. 1931. Check-list of birds of the world. 4th Ed. Vol. I. Cambridge: Harvard Univ. Press.

Petrides, G. A. 1944. Sex ratios in ducks. Auk 61(4):564-571.

Petrides, G. A. and Bryant, C. R. 1951. An analysis of the 1949-50 fowl cholera epizootic in Texas Panhandle waterfowl. N. A. Wildlife Conf. Trans. 16:193-216.

Rosen, M. N. and Bischoff, A. I. 1949. The 1948-49 outbreak of fowl cholera in birds in the San Francisco Bay area and surrounding counties. Calif. Fish and Game 35:185-192.

_______ 1950. The epidemiology of fowl cholera as it occurs in the wild. N. A. Wildlife Conf. Trans. 15:147-153.

Schmidt, K. P. and Davis, D. D. 1941. Field book of snakes of the United States and Canada. New York: G. P. Putnam's Sons.

Sowls, Lyle K. 1949. A preliminary report on renesting in waterfowl. N. A. Wildlife Conf. Trans. 14:260-275.

_______ 1950. Techniques for waterfowl nesting studies. N. A. Wildlife Conf. Trans. 15:478-489.

Spencer, H. E. 1953. The cinnamon teal (Anas cyanoptera Vieillot): its life history, ecology, and management. (M. S. Thesis, Dept. of Wildlife) Logan, Utah: Utah State Agricultural College.

U. S. D. A. 1941. Climate and man: Yearbook of Agriculture. Washington: Government Printing Office.

U. S. D. C. 1951. Climatological data. Utah. Vol. 53, Nos. 1-13. Washington: U. S. Weather Bureau.

_______ 1952. Climatological data. Utah. Vol. 54, Nos. 1-13. Washington: U. S. Weather Bureau.

Van Den Akker, J. B. and Wilson, V. T. 1949. Twenty years of bird banding at Bear River Migratory Bird Refuge, Utah. Jour. Wildlife Mgt. 13(4):359-376.

Wetmore, Alexander. 1919. Lead poisoning in waterfowl. U. S. D. A. Bul. 793.

Williams, C. S. and Marshall, W. H. 1937. Goose nesting studies on Bear River Migratory Waterfowl Refuge. Jour. Wildlife Mgt. 1:77-86.

_______ 1938. Duck nesting studies, Bear River Migratory Waterfowl Refuge. Jour. Wildlife Mgt. 2:29-48.

Wolf, Kenneth. 1952. Some effects of fluctuating and falling water levels on waterfowl production. (M. S. Thesis, Dept. of Wildlife) Logan, Utah: Utah State Agricultural College.

Yocum, C. F. 1951. Waterfowl and their food plants in Washington. Seattle: University of Washington Press.

Appendix Table 1. Partial list of plants at Ogden Bay Bird Refuge

Aquatics

Arrowgrass (Triglochin maritima)
Arrowhead (Sagittaria spp.)
Bulrush, alkali (Scirpus paludosus)
Bulrush, common three-square (S. americanus)
Bulrush, hardstem (S. acutus)
Bulrush, Olney's three-square (S. olneyi)
Bulrush, softstem (S. validus)
Cattail, common (Typha latifolia)
Cattail, narrow-leaved (T. angustifolia)
Coontail (Ceratophyllum demersum)
Cutgrass, rice (Leersia oryzoides)
Dock (Rumex crispus)
Duckweed (Lemna minor)
Duckweed, big (Spirodela polyrhiza)
Glasswort (Salicornia rubra)
Glasswort (S. pacifica var. utahensis)
Millet (Echinochloa crus-galli)
Muskgrass (Chara spp.)
Najad (Najas guadalupensis)
Plantain, water (Alisma plantago-aquatica)
Pondweed, horned (Zannichelia palustris)
Pondweed, longleaf (Potamogeton americanus)
Pondweed, sago (P. pectinatus)
Pondweed, variableleaf (P. gramineus)
Reed, common (Phragmites communis)
Rushes (Juncus spp.)
Rush, wire (J. balticus)
Sedges (Carex spp.)
Sedge (C. aquatilis)
Sedge, Nebraska (C. nebraskensis)
Smartweed (Polygonum amphibium)
(P. coccineum)
(P. lapathafolium)
(P. pensylvanicum)
(P. persicaria)
Spikerushes (Eleocharis spp.)
Widgeongrass (Ruppia maritima)

Grasses

Barley, foxtail (Hordeum jubatum)
Brome, smooth (Bromus inermus)
June grass (B. tectorum)
Rabbitfoot grass (Polypogon monspeliensis)
Saltgrass, desert (Distichlis stricta)
Wheat-grass (Agropyron spp.)
Wild rye (Elymus canadensis)

Appendix Table 1. (continued)

Weeds

Asparagus (Asparagus officinalis)
Bassia (Bassia hyssopifolia)
Beggar tick (Bidens cernua)
Burdock (Arctium minus)
Cocklebur (Xanthium spp.)
Goldenrod (Solidage spp.)
Gooseberry (Ribes spp.)
Horsetail (Equisetum arvense)
Iva (Iva xanthifolia)
Lamb's quarters (Chenopodium spp.)
Lettuce, prickly (Lactuca serriola)
Licorice (Glycyrriza lepidota)
Milkweed (Asclepias speciosa)
Mint (Mentha spp.)
Morning glory (Convolvulus arvensis)
Mullein (Verbascum thapsus)
Mustard (Brassica spp.)
Nettle, hedge (Stachys palustris)
Nettle, stinging (Urtica gracilis)
Peppergrass (Lepidium spp.)
Pigweed (Amaranthus retroflexus)
Prickly pear (Opuntia rhodantha)
Primrose, evening (Oenothera spp.)
Ragweed (Ambrosia spp.)
Rose, wild (Rosa spp.)
Saltbush (Atriplex spp.)
Seepweed (Suaeda spp.)
Sunflower (Helianthus annuus)
Sweetclover, white (Melilotus alba)
Sweetclover, yellow (M. officinalis)
Teasel (Dipsacus sylvestris)
Thistle (Circium spp.)
Virgin's bower (Clematis spp.)
Yarrow (Achillea lanulosa)

Brush and Trees

Greasewood (Sarcobatus vermiculatus)
Rabbitbrush (Chrysothamnus spp.)
Sagebrush (Artemesia tridentata)
Snakeweed (Gutierrezia sarothrae)
Cottonwood (Populus angustifolia)
Maple (Acer spp.)
Russian olive (Elaeagnus angustifolia)
Tamarisk (Tamarix gallica)
Willow (Salix spp.)

Appendix Table 2. A partial list of waterfowl and associated marsh birds and mammals at Ogden Bay Bird Refuge

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Birds

Baldpate (Mareca americana)
Bufflehead (Bucephala albeola)
Canvasback (Aythya valisineria)
Gadwall (Anas strepera)
Goldeneye, Am. (Bucephala clangula americana)
Goldeneye, Barrows (Bucephala islandica)
Goose, Great Basin Canada (Branta canadensis moffitti)
Goose, White-fronted (Anser a. albifrons)
Goose, Lesser Snow (Chen h. hyperborea)
Mallard, Common (Anas p. platyrhynchos)
Merganser, American (Mergus merganser americanus)
Merganser, Red-breasted (Mergus serrator)
Pintail, American (Anas acuta tzitzihoa)
Redhead (Aythya americana)
Ring-necked Duck (Aythya collaris)
Ruddy Duck (Oxyura jamaicensis rubida)
Scaup, Lesser (Aythya affinis)
Scaup, Greater (Aythya marila nearctica)
Shoveller (Spatula clypeata)
Swan, Whistling (Cygnus columbianus)
Teal, Blue-winged (Anas discors)
Teal, Cinnamon (Anas c. cyanoptera)
Teal, Green-winged (Anas carolinensis)
Woodduck (Aix sponsa)

Avocet (Recurvirostra americana)
Bittern, American (Botaurus lentiginosus)
Blackbird, Brewer (Euphagus cyanocephalus)
Blackbird, Red-winged (Agelaius phoeniceus fortis)
Blackbird, Yellow-headed (Xanthocephalus xanthocephalus)
Coot, American (Fulica americana)
Cormorant, Double-crested (Phalacrocorax a. auritus)
Crane, Sandhill (Grus canadensis tabida)
Curlew, Long-billed (Numenius a. americanus)
Dowitcher (Limnodromus grissus scolapaceus)
Egret, Brewster's (Leucophoyx thula brewsteri)
Godwit, Marbled (Limosa fedoa)
Grebe, Eared (Colymbus nigricullis californicus)
Grebe, Horned (Colymbus auritus)
Grebe, Pied-billed (Podilymbus p. podiceps)
Grebe, Western (Aechmophorus occidentalis)
Gull, California (Larus californicus)
Gull, Franklin (Larus pipixcan)
Gull, Ring-billed (Larus delawarensis)
Hawk, Duck (Falco peregrinus)
Hawk, Marsh (Circus hudsonius)
Heron, Black-crowned Night (Nycticorax n. hoactli)
Heron, Great Blue (Ardea herodias)
Ibis, White-faced Glossy (Plegadis guarauna)

Appendix Table 2. (continued)

Birds

Killdeer (Charadrius v. vociferus)
Owl, Short-eared (Asio f. flammeus)
Pelican, White (Pelecanus erythrorhynchus)
Phalorope, Northern (Lobipes lobatus)
Phalarope, Wilson (Steganopus tricolor)
Pheasant, Ring-necked (Phasianus colchicus torquatus)
Rail, Sora (Porzana carolina)
Rail, Virginia (Rallus limicola limicola)
Sandpiper, W. Solitary (Tringa solitaria cinnamomea)
Sandpiper, Spotted (Actites macularia)
Snipe, Wilson's (Capella gallinago delicata)
Stilt, Black-necked (Himantopus mexicanus)
Tern, Black (Chlidonias nigra surinamensis)
Tern, Caspian (Hydroprogne caspia imperator)
Tern, Common (Sterna h. hirundo)
Tern, Forster (Sterna forsteri)
Willet, Western (Catoptrophorus semipalmatus inornatus)
Wren, Western Marsh (Telmatodytes palustris plesuis)
Yellowlegs, Greater (Totanus melanolencus)
Yellowlegs, Lesser (T. flavipes)

Mammals

Badger (Taxidea taxus)
Beaver (Castor canadensis)
Deer, Mule (Odocoileus hemionus)
Mouse, Meadow (Microtus montanus)
Muskrat (Ondatra zibethica osoyoosensis)
Mink (Mustela vison)
Porcupine (Erithizon epixanthum)
Rabbit, Jack (Lepus townsendii)
Skunk, Common (Mephitis mephitis)
Weasel, Bonaparte (Mustela cicognani)

Appendix Table 3. Monthly climatological data for the Ogden Bay Area - 1951 and 1952 (U. S. D. C., 1951 and 1952)

1951			1952	
Average Temperature (Fahrenheit)	Total Precipitation (inches)	Month	Average Temperature (Fahrenheit)	Total Precipitation (inches)
27.1	1.43	Jan.	27.4	2.69
35.2	1.08	Feb.	27.1	1.29
37.4	0.74	March	33.4	2.61
51.7	3.74	April	52.3	0.92
58.8	1.60	May	60.5	0.69
63.5	0.08	June	68.2	1.58
74.9	0.73	July	73.7	0.01
72.0	2.68	Aug.	74.6	0.80
63.5	0.13	Sept.	67.4	0.04
50.8	1.58	Oct.	56.7	0.00
37.5	2.51	Nov.	35.4	1.21
27.8	2.08	Dec.	31.3	0.59
50.1	18.38	Annual	50.7	12.43

Last spring snowfall
1951 -- April 30 -- 2.5 inches
1952 -- March 24 -- 4.2 inches

Last spring minimum of 32 degrees or lower
1951 -- April 22
1952 -- April 9

First fall minimum of 32 degrees or lower
1951 -- October 18
1952 -- October 24

Length of growing season (frost-free)
1951 -- 179 days
1952 -- 198 days